HOUSE OF COMMONS SESSION 2000–2001

SCIENCE AND TECHNOLOGY COMMITTEE

Sixth Report

ARE WE REALISING OUR POTENTIAL?

Volume II

Appendices to the Minutes of Evidence

Ordered by The House of Commons *to be printed*
28 March 2001

PUBLISHED BY AUTHORITY OF THE HOUSE OF COMMONS
LONDON – THE STATIONERY OFFICE LIMITED

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The Science and Technology Committee is appointed to examine on behalf of the House of Commons the expenditure, administration and policy of the Office of Science and Technology (and any associated public bodies). Its constitution and powers are set out in House of Commons Standing Order No. 152.

The Committee has a maximum of eleven members, of whom the quorum for any formal proceedings is three. The members of the Committee are appointed by the House and unless discharged remain on the Committee until the next dissolution of Parliament. The present membership of the Committee is as follows:[1]

Dr Michael Clark MP (*Conservative, Rayleigh*)[2]
Sir Paddy Ashdown MP (*Liberal Democrat, Yeovil*)[6]
Dr Ian Gibson MP (*Labour, Norwich North*)[2]
Dr Brian Iddon MP (*Labour, Bolton South East*)[5]
Mr Robert Jackson MP (*Conservative, Wantage*)[3]
Dr Lynne Jones MP (*Labour, Birmingham Selly Oak*)[2]
Dr Ashok Kumar MP (*Labour, Middlesborough South and East Cleveland*)[2]
Mr Tony McWalter MP (*Labour, Hemel Hempstead*)[7]
Mr Ian Taylor MP (*Conservative, Esher and Walton*)[4]
Dr Desmond Turner MP (*Labour, Brighton Kemptown*)[2]
Dr Alan W Williams MP (*Labour, Carmarthen East and Dinefwr*)[2]

On 30 July 1997, the Committee elected Dr Michael Clark as its Chairman.

The Committee has the power to require the submission of written evidence and documents, to examine witnesses, and to make Reports to the House.

The Committee may meet at any time (except when Parliament is prorogued or dissolved) and at any place within the United Kingdom. The Committee may meet concurrently with other committees or sub-committees established under Standing Order No. 152 for the purposes of deliberating, taking evidence or considering draft reports. The Committee may meet concurrently with the House's European Scrutiny Committee (or any of its sub-committees) or the Environmental Audit Committee for the purposes of deliberating or taking evidence. The Committee may exchange documents and evidence with any of these committees, as well as with the House's Public Accounts and Deregulation Committees.

The Reports and evidence of the Committee are published by The Stationery Office by Order of the House. All publications of the Committee (including press notices) are on the Internet at www.parliament.uk/commons/selcom/s&thome.htm.

All correspondence should be addressed to The Clerk of the Science and Technology Committee, Committee Office, 7 Millbank, London SW1P 3JA. The telephone number for general inquiries is: 020 7219 2794; the Committee's e-mail address is: scitechcom@parliament.uk.

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[1] Mrs Caroline Spelman MP (*Conservative, Meriden*) was appointed on 14 July 1997 and discharged on 22 June 1998.
Mr David Atkinson MP (*Conservative, Bournemouth*) was appointed on 14 July 1997 and discharged on 30 November 1998.
Mrs Jacqui Lait MP (*Conservative, Beckenham*) was appointed on 22 June 1998 and discharged on 5 July 1999.
Mr Nigel Beard MP (*Labour, Bexleyheath and Crayford*) was appointed on 14 July 1997 and discharged on 20 March 2000.
Mr Nigel Jones(*Liberal Democrat, Cheltenham*) was appointed on 14 July 1997 and discharged on 15 May 2000.
Mrs Claire Curtis-Thomas (*Labour, Crosby*) was appointed on 14 July 1997 and discharged on 13 March 2001.

[2] Appointed on 14 July 1997.

[3] Appointed on 5 July 1999.

[4] Appointed on 30 November 1998.

[5] Appointed on 20 March 2000.

[6] Appointed on 15 May 2000.

[7] Appointed on 13 March 2001.

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1. Annex to Memorandum submitted by the Save British Science Society
2. Appendices to Memorandum submitted by the Particle Physics and Astronomy Research Council
3. Appendices to Memorandum submitted by Rolls-Royce plc
4. Appendices to Memorandum submitted by the Association of the British Pharmaceutical Industry
5. Appendix to Memorandum submitted by Professor D H Saxon, University of Glasgow
6. Annex to Memorandum submitted by the Royal College of Veterinary Surgeons
7. Annex to Memorandum submitted by the Association of Veterinary Teachers and Research Workers

APPENDICES TO THE MINUTES OF EVIDENCE

APPENDIX 1

Memorandum submitted by Mr Colin S J McCarthy

In general and without going into detail the Strategy for Science Engineering and Technology, particularly Technology Foresight, has made very good progress, but, it is important when conducting an inquiry such as this to ask the correct questions to the best people able to give an impartial and considered view. It is increasingly apparent that objectivity has been lost in a lot of Government surveys and the influence of the "London in crowd" seems to be too strong. This can best be exemplified using eg unemployment statistics, in regions outside London large numbers of people (approximately three million looking for paid employment) many who still want to work have been encouraged to take early retirement or unpaid voluntary work, etc because they are over 50 years old. Similary the under 50 year olds (again approximately another three million looking for paid employment) are hidden in training schemes, are in and out of short term contracts, or just do not show up on any government statistics. The fact that official Government figures show approximately one million claiming benefits is contrary to the majority of the populations experience, they therefore distrust all Government statistics—this is very serious as large parts of the population lose trust in the democratic process and it becomes difficult to conduct reasoned scientific debate.

At the same time the dumbing down of the majority of the British economy means that vacancies are often filled by relatively less able people (often young people replacing older more experienced workers who have been forced out) who are good at boring repetitive tasks and also do not "rock the boat". There is no place in an asset stripping short term share price driven economy for innovators and companies that look to long-term product development. Please do not consider the "dotcom" company success? as a reason for optimism as the funds taken by these, mostly unsustainable companies, are partly responsible for the failures of more established companies (along with the Pound and Euro problems).

I believe it is difficult to comment on the many successes that came from "Realising our Potential" such as "Foresight" because macroeconomic trends at present seem so damaging to such processes. Why did the Government give in to what to most people seems to be undue pressure by the Welcome Trust to site the DIAMOND synchrotron radiation source at the Rutherton Appleton Laboratory, Oxford. It is obvious to most in the scientific community that DIAMOND should have been sited at the Daresbury Laboratory near Manchester. The technical arguments have been covered well by the media but the decision gives the impression of big problems in Government. The decision reinforces the impression of a North/South divide and will go against plans to reduce housing demand and reduce traffic congestion problems in the south. These negative factors may well cause losses in excess of the £100 million to be provided by the Welcome Trust.

There are lots of good things that could be included in the "Call for Evidence" but unless the Science and Technology Committee sorts out the issues I have highlighted I believe these good points will be sidelined.

I have applied for paid employment, in the past, at the Government Office of the West Midlands and other Government organisations in Staffordshire and the West Midlands because the problems are so complex and can not be solved just by consultation exercises, but I have been unsuccessful in gaining paid employment.

Why is it so difficult to get paid employment in the Staffordshire area, I am only 44 years old? Why do members of the Government find it so hard to employ people who are resident outside London?

Why do so many residents from the South East have to commute to work in the North when there are very large numbers having to commute from the North to work in the South East? Why is London becoming a place where only people from highly paid professions eg stockbrokers can afford to live?

Do the Science and Technology Committee accept that undemocratic global companies have more influence on the Government than is reasonable?

8 May 2000

APPENDIX 2

Memoranda submitted by Professor D H Saxon, FRSE, Head of Department of Physics and Astronomy, University of Glasgow

This is a personal submission indicating some areas of concern. As requested I give first some information on my involvement in Research Council Matters:

PPARC Council member (since 1997), Chair Public Understanding of Science Panel. (since 1997). (1992–95 covering transition from SERC) I was Chairman of the Particle Physics Committee and member of the UK delegation to CERN Council.

CCLRC Chair the Particle Physics Users Advisory Committee (since 1998).

MRC Member of the Scientific Advisory Group on Technology (1999). Judge for Discipline-hopping awards (2000).

Overseas involvements:

CERN, Geneva Member *ad personam* of Scientific Policy Committee (1993–98).

DESY, Hamburg Member, Physics Research Committee (1993–99).

Learned Societies

Roy Soc Ed Chair of Physics Sectional Committee and member of Meetings Committee. Chair sub-committee for PPARC-RSE Enterprise Fellowships.

Inst of Physics Member of Degree accreditation committee.

The comments relate to my own experience. There are many good things to say, for example, the limited remit of PPARC has given it excellent focus. Here are some less good things.

1. The White Paper seemed to assume that Research was in good health and this will continue without long-term attention to human resources, infrastructure and facilities. The emphasis was on reorientation of goals and little thought was given to the measures needed to sustain quality of performance.

2. The White Paper failed totally on the issue of the managing, development and renewal of central facilities. As a result CCLRC had later to be set up, but under an underfunded and flawed scheme, (happily now being reviewed). There is no systematic approach to new capital facilities. There have been extreme difficulties throughout in approving and now in setting up the management for the new synchrotron radiation source. As a result the UK has (a) suffered loss of expertise in managing capital projects; (b) given itself no bargaining position in international negotiations; (c) failed properly to exploit those facilities we do have. The EPSRC ticket scheme has proved to be an inappropriate way to provide tensioning between big and small science. It has led to expensive facilities being underused, a high rejection rate on proposals, and would-be users being demoralised.

3. It failed to provide enough resourcing for infrastructure and capital, with an over-emphasis on short-term wins. The Research Councils and Funding Councils together have failed to deliver enough resource for University research infrastructure. There has been a progressive decline. The JIF mechanism has been a sparsely effective response with an emphasis on flagship projects rather than maintaining quality across the patch. It is highly inefficient with only a 12 per cent success rate, and extraordinarily burdensome to apply for and then to administer. It has hugely complex rules that pull in different directions.

4. It has not addressed the distortion caused by charities not paying indirect costs. This lack of transparency has forced Universities to divert resources out of, say, physical sciences into biomedical to make good the shortfalls and infrastructure costs needed to support charity-funded work.

5. It has neglected the future of human resources by failing to maintain competitive salaries for academics and postgraduate students. The position for students entering Ph Ds is now dire. They come in with massive debts and face several years of hand to mouth funding for the prospects of £18,000 at age 27 with a Ph D, as against £20,000 being offered to 21 year old B Sc's in the same field. The EPRSC proposal for training accounts will reduce student numbers, create destructive competition between institutes, and force Universities into seeking top-up funding from other sources to avoid slipping back, instead of getting on with the job.

6. On Public Understanding of Science there is good and bad to report. At the level of contact between enthusiastic researchers and young people there is much that is good. But there are three big problems (a) the very low level of public awareness on science content. Schemes from abroad have to be dumbed down for UK consumption. (b) The media give prominence to American scientists even where the work was done in the UK—partly from the need to sell programmes in the USA whereas the UK is a captive market, and partly from a larger supply and a greater degree of fluency amongst American scientists. This does not provide role models for British children. (c) Scientists and the media have failed to understand each other repeatedly. Progressively, important fields of, for example, environmental discussion have become politicised and discussion reduced to sloganising by pressure groups who are indifferent to whether their arguments are true or not. Consider nuclear power, dumping old oil rigs, or genetically modified foods.

22 May 2000

Further memorandum submitted by Professor D H Saxon, University of Glasgow

You asked about my sentence: "schemes from abroad have to be dumbed down for UK consumption." Here is my personal experience in this area. As chairman of the PPARC Public Understanding of Science Panel I was aware that there are first-rate Astronomical exhibitions and public facilities such as planetaria in the UK, but we wanted to provide something to tell people about Particle Physics. The idea of a travelling exhibition that could go to Science Centres and elsewhere was the result. There is an existing exhibition run by CERN that travels all over Europe and my first thought was to copy that and add some UK emphasis. CERN have been very supportive throughout in this venture.

I had already hosted the previous version of the CERN exhibition in Glasgow in 1997 and formed the view that it is fine as a place to talk to schoolchildren and then let them explore it, but that without an interpreter it was rather heavy going for them. Visits by two UK Museums experts to see the present CERN exhibition in Stockholm and Naples gave the same advice. They would not have this in their Museum. It was too far above the heads of the public.

The (British) co-ordinator of the present CERN exhibition tells me that it is a big success in many countries (Finland, Sweden, Norway, Denmark, Portugal, Spain, Italy and France.) He cites amongst his evidence questionnaire returns from visitors. It has been seen by 300,000 visitors and is in demand for future venues. Most visitors stay 30–60 minutes.

We (PPARC) therefore commissioned a "prior knowledge" survey of people entering museums in the UK to assess levels of awareness and understanding of astronomy and particle physics. (I can supply a copy if desired—150 pages). We looked at concepts like: electron, quark, the big bang, galaxy, solar wind, star, particle accelerator. It is the outcome of this study which has informed our work.

I attach for your information copies of the exhibition script to the CERN exhibition and the present state of work in progress on our UK derivative of it.* The UK exhibition is deliberately smaller to fit into more venues, but the reduction in conceptual level should also be clear. This document is confidential and is work in progress, so please treat it as such.

The conclusions might be that the conceptual prior knowledge in the UK is weaker, or that UK audiences are less willing to put effort into understanding something new, or possibly that they are less tolerant of presentations that simply go over their heads. I don't know. There is some evidence (National Foundation for Educational Research) that English children at age 13 compare well with Western Europe in Science performance but lag behind the best in Maths. One can speculate that we fall behind in Science later due to early specialisation.

That is my own personal knowledge of this question. It squares with other personal impressions such as the high level of scientific and mathematical fluency of foreign exchange students coming into my Department, but that is another story.

13 July 2000

APPENDIX 3

Memorandum submitted by the Clerk of the Committee from Professor Geoff Simon, Chair, British Society of Animal Science Technical and Ethical Committee

1. The annual Forward Look report is welcome.

2. While Technology Foresight may help Parliamentarians understand the direction of scientific research, we are not confident that it has done much to facilitate industrial-academic interaction, or been of particular benefit to the life science community.

3. The Council for Science and Technology (within the Office of Science and Technology) has not been as visibly active as its precursor ACOST. However, the role remains an important one.

4. The academia-industry interface still needs to be developed. That the DTI lost much of its R&D budget since the last White Paper has not helped. That other Civil Departments (especially MAFF) have had their R&D budgets decline, again has not helped. That the cuts in military/defence R&D have not been transferred to either civil science (be it Departmental R&D or the Science Base) has been a lost opportunity.

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* *Not printed.*

5. Schemes such as the Teaching Company Directorate have been successful and welcome.

6. The new Research Council mission statements with their explicit commitment to wealth creation and the quality of life may be threatening blue skies research. The big breakthroughs do not necessarily have an immediate commercial application. The merger of the AFRC with the SERC has not preserved whole-organism agricultural research. We now need such research in order to realise the whole-organism applications of the past decade's molecular discoveries.

7. The creation of a co-ordinating post of DG of the Research Councils has been beneficial.

8. The theme of wealth creation and quality of life is most applicable to technology and engineering (including bio-engineering), but it should not be allowed to constrain pure research which is where most of the big breakthroughs originate.

9. The future:

(a) the UK has to position itself to reap the most from the post-genome challenges;

(b) to do this we need to ensure that science attracts and retains the very best. Short term contracts and career structures need to be addressed urgently. Administrative bureaucracy is still stifling;

(c) the decline in science funding, having been halted, must return to its mid-1980 real term levels.

5 June 2000

APPENDIX 4

Memorandum submitted by the Association of Independent Research and Technology Organisations (AIRTO)

INTRODUCTION: AIRTO CREDENTIALS

AIRTO is the largest community of private sector contract research and technology consulting companies in Europe. Its turnover, which exceeds £1 billion per year, and its employment of over 10,000 scientists and engineers, means it is larger than other European organisations such as the Fraunhofer Gesellschaft and TNO. AIRTO is situated in the private sector. Unlike Fraunhofer and TNO it does not receive government grant nor does it seek such subsidy. The member companies of AIRTO are exemplars of knowledge traders in a developing knowledge-driven economy.

Attached to this response to consultation are the following AIRTO documents*:

- summary of AIRTO Recommendations for a Science and Innovation Policy;
- increasing UK innovation intensity and the solution to the problem of knowledge transfer to business enterprise;
- AIRTO response to the DTI proposal for a network of regional centres for manufacturing excellence and productivity.

AIRTO RESPONSE TO CONSULTATION ISSUES REQUESTED BY THE SCIENCE AND TECHNOLOGY COMMITTEE

1. *The extent to which the objectives set out in the 1993 White Paper, "Realising our Potential", have been delivered.*

The objectives have been achieved in part. They have caused focus by government and academia on issues relevant to innovation in the UK economy. Thus some topics pursued through academic research have been re-orientated towards subjects of greater wealth creating relevance. The impact on changing culture and attitudes in industry has been minimal. There remain issues of non-connectivity between government departments and the initiatives they take to assist industry. A similar situation prevails—lack of connectivity—between the outputs of the science base (the universities) and its value-added application in industry. The fundamental problems continue to be the competence and attitudes in industry management towards innovation and risk taking combined with the apparent lack of support by government to creating a market in value-added knowledge transfer.

**Not printed.*

2. *Whether the objectives and themes of the 1993 White Paper remains appropriate to the development of a strategy for science, engineering and technology and, if not, what other themes and objectives would be more beneficial?*

The objectives of the original White Paper remain valid. The only change required is to ensure that a future White Paper focuses on changing attitudes, behaviour and investment in innovation in industry. This requires creation of a market in knowledge trading in the private sector. The attached papers from AIRTO offer a contribution to solution of this challenge.

3. *Whether attempts to deliver the proposals of the 1993 White Paper have resulted in culture change across, or in parts of, the science, engineering and technology base, and if so, what is the nature of this change and how has it been demonstrated?*

Some change has been achieved in the science base (academia). Research programmes undertaken in universities, supported by Research Councils, have been re-orientated towards greater relevance to wealth creation and economic activity in industry. Little change has been achieved in industry attitudes or behaviour. There remains a lack of coherent policy in developing a marketplace for value-added knowledge transfer essential to the development of a knowledge-driven economy. That should now be the focus of SET policy.

4.1 *Sustaining the excellence of science and technology base*

Government policy, and notably that of the DTI, in urging universities to act as knowledge traders is likely to weaken unintentionally the science base. In general, universities are not equipped to act as knowledge traders. Trading with SMEs is a singularly unhelpful activity to the primary purpose of a university.

The university "business" structure is under pressure. This pressure will continue to grow from global competition to attract students. It is essential for the UK to maintain a core of high quality universities which are players in the first rank of global academic research. For this to be feasible a radical change in funding and objectives, set by public policy for university management, must be investigated. Present policy is not contributing to the continuation of high quality curiosity driven research in UK universities.

4.2 ENCOURAGING PRIVATE INVESTMENT IN INNOVATION

Recent fiscal measures have contributed to improving investment in innovation. However there remains the problem of early stage funding. The issue is to provide a mechanism with the competences to understand innovative ideas before they become a business proposal. The venture capital industry is singularly lacking in this skill in the UK. AIRTO has taken an initiative—which may be attributed to the policy framework set by the original White Paper—to establish a unique organisation to nurture private investment in innovation. That initiative is E-SYNERGY Limited. The support provided to this initiative through public policy is minimal. Yet networking investment initiatives in early stage funding would boost innovation intensity at little public cost. It should be a feature of the proposed White Paper.

4.3 STREAMLINING KNOWLEDGE TRANSFER SCHEMES AND FOCUSING THEM ON CLEAR GOALS

In this area the implementation of the original White Paper has failed. Government has introduced an array of schemes, which confuse recipients by their variety and bureaucracy. With the development of Regional Development Agencies (RDAs) this problem is set to become worse. Government should desist from promotional and advisory schemes—which are generally perceived as unhelpful to industry—and should focus instead on short-term fiscal incentives to companies to participate in real knowledge transfer to upgrade the competencies and competitiveness of their business. AIRTO has long advocated this change but with little effect in government policy. The attached documents elaborate this issue.

4.4 FOSTERING REGIONAL NETWORKS

At a time when information and communications technology (ICT) is growing rapidly, there is undue emphasis on physical regional networks. Informal knowledge exchange between senior staff of companies on a regional basis can be a useful stimulant. The issue is one of balance. The other issue is too many operators attempting to play in the same area. If Regional Development Agencies are to be the strategy for the future, they should be held responsible for implementing regional networks wherever there is a market demand for such support services. Another aspect of RDAs is the necessity to ensure they understand the need for global inputs. "Regional" is otherwise liable to become synonymous with "parochial". AIRTO has advocated structures to overcome this problem but as yet has not received response from the DTI.

4.5 IMPROVING THE FLOW OF SKILLED SCIENTISTS AND ENGINEERS TO INDUSTRY

This is essential to the future of the UK economy. Several elements are necessary for this flow to operate effectively. First, universities must be held accountable to make this their priority. Second, academic research must feed the quality of teaching to ensure relevance in attitudes, culture and competences of graduating students. Relevance of the skills of graduating students can be significantly improved by activities such as Faraday Partnerships. The record of support by government (excluding Research Councils which have been positive) to Faraday Partnerships has been variable and must be improved. The impact of the RAE on attitudes and relevance of graduates is questionable, and requires investigation and revision.

4.6 IMPROVING THE ABILITY OF THE SCIENCE BASE TO PLAY A ROLE IN THE KNOWLEDGE ECONOMY

The greatest contribution the science base (academia) can play in the knowledge economy is to produce students appropriate to future needs. The other role is to develop partnerships with intermediaries so that outputs from curiosity driven fundamental research are translated into value-added products which may be applied to change practice and culture in industry. In present government policy there is no focus on the need to develop a profitable and growing knowledge-transfer sector. Without that focus, it will be impossible to ensure that the proper role of the science base is contributed, through knowledge-transfer to industry.

4.7 TAKING ADVANTAGE OF THE GLOBALISATION OF RESEARCH

Globalisation of research requires agents to network with all sources and to translate the outputs into a product which may be absorbed in industry. It is the role of intermediaries, such as AIRTO members. There is no provision in government policy to nurture this activity. Also, AIRTO has advocated "virtual" linking of leading universities into global networks for participation in, and exchange of, global research results. One obvious area for government to pioneer such change is to create networks of universities in the EU to replace many of the present activities and expenditure on Joint Research Centres (JRCs). AIRTO and CVCP are in harmony on this topic but there is little governmental policy support to its development.

4.8 IMPROVING PUBLIC CONFIDENCE BY CREATING GREATER TRANSPARENCY IN THE REGULATION OF SCIENCE

In general, AIRTO is not engaged in aspects of public confidence related to research. Nevertheless, it recognises the necessity for government to manage its relations with the media in the context of science related issues. In the past, for example BSE, this management function has not been fulfilled with distinction.

5. *What do you believe should be the main features of the modern strategy for science, engineering and technology and why?*

The focus for policy on science, engineering and technology must be wealth creation with social benefit. That was stated clearly in the original White Paper. It remains the central objective. Some progress has been made on this objective. However there remains the tendency for government policy to drift towards focus only on the academic science base. The critical issue is to change attitudes and practices in industry and to create a trading market in knowledge transfer. This requires a refocusing of policy. Also, because there is manifest market failure, some degree of short-term intervention will be necessary to change industry attitudes and practices. The attached AIRTO documents elaborate on this subject.

May 2000

APPENDIX 5

Memorandum submitted by the Institution of Professionals, Managers and Specialists (IPMS)

INTRODUCTION

1. The Institution of Professionals, Managers and Specialists (IPMS) is a trade union representing 75,000 scientific, technical and specialist staff in the Civil Service, Research Councils, other public sector bodies and an increasing number of private sector companies. IPMS members are involved in a very wide range of science, engineering and technology functions, from long term environmental research to defence engineering and from very large space projects to forensic DNA testing. We commented in detail to the Minister for Science, William Waldegrave, both orally and in writing before publication of the 1993 White Paper and have submitted views subsequently in response both to government consultation papers and Select Committee inquiries on issues of wide relevance to the future of science, engineering and technology. These include

submissions on the Prior Options Reviews[1] and the more recent Baker study[2]; the Foresight programme[3] and the Forward Look; the scientific advisory system[4]; aspects of energy policy[5]; and on proposals to privatise the Defence Evaluation and Research Agency[6]. It is not our intention to reiterate earlier submissions in response to the Select Committee's current inquiry, though many of the themes remain pertinent and we should be glad to provide any further information and background documents that may be helpful.

2. In addressing the specific issues identified by the Select Committee, our views are as follows:

THE EXTENT TO WHICH THE OBJECTIVES SET OUT IN THE 1993 WHITE PAPER "REALISING OUR POTENTIAL" HAVE BEEN DELIVERED

Annual publication of the Forward Look

3. The Forward Look is an extremely useful reference source, though its overall value has been reduced by discontinuity in the series. The 1999 Forward Look was the first to be published since 1996. However, *"Science, Engineering and Technology Statistics"*, an essential accompaniment to the Forward Look was not published last year. Thus it has become more difficult to undertake satisfactory longer term analysis, for example of trends in SET expenditure, and to build a clear understanding of the broader picture. For instance, the analyses of business expenditure on R&D, international comparisons and information on employment in R&D are all included in *"Science, Engineering and Technology Statistics"*. The provision of good quality, continuous data is essential for interpreting the impact of policy and expenditure decisions. IPMS therefore strongly agrees with the Select Committee's conclusion in their report on *"Government Expenditure on Research and Development: The Forward Look"* that annual publication should be resumed. This should include annual publication of the *"Science, Engineering and Technology Statistics"*. We also agree that data on expenditure should be matched more closely to policy objectives and the achievement of departmental science strategies.

Creation of Foresight

4. IPMS has broadly welcomed the way in which the Foresight process has evolved. For example, our response to the Office of Science and Technology's 1998 consultation on the Foresight programme welcomed the emphasis on the social dimensions of change as well as market trends. However, although the Foresight process has generally been regarded as successful in fostering networking, there are still doubts about its effectiveness in follow through and monitoring. The Foresight Steering Group itself identified several areas where government and its agencies need to take a lead. For example, it recommended developing long term sources of funding to take forward projects and using government procurement to stimulate technology. The need for resources to maintain the Foresight process must be addressed, particularly if a wider range of interests is to be encouraged to participate. For example, many SMEs do not have the human or financial resources to participate. State funding may make the difference between participating in the process or not.

5. In terms of the sector panels, we believe that it is particularly important to capture the views of SMEs, working scientists and others at the cutting edge, whether research providers or those involved in marketing or defining the "customer" demand. It is also important, particularly in the quality of life aspects of research, to involve a wider range of interests such as consumers and environmental groups, trade unions and the public at large. It is an important omission that, although the TUC General Secretary sits on the Foresight Steering Group, there is no trade union representation on the sector panels. This is the level at which experts and practitioners in the relevant fields can make a substantive contribution. Those who also work actively within their union would bring the added benefits of social partnership; a dimension the Government is keen to encourage in other aspects of public life. The membership of all the sector panels should be refreshed to ensure complete gender balance.

Replacement of the Advisory Council on Science and Technology by the Council for Science and Technology

6. The Council for Science and Technology (CST) has been fairly quiet in comparison with the Advisory Council on Science and Technology (ACOST), though its 1999 "Review of S&T Activity Across Government" is very useful. It is to be hoped that the recommendations in that report will be taken up by government. In particular, the recommendations on science strategy are highly relevant to the current considerations about a new science White Paper.

Interchange of ideas between the science base and industry

7. The Government has made clear its view that "spinning-off" successful commercial ventures should be a key objective of public sector research activity. IPMS agrees that a knowledge transfer culture needs to be embedded in PSREs, though we also believe that an approach based solely on the commercial value of research activities cannot hope to do justice to the "public good" value of science or to reward fairly the scientists that work in this area. Furthermore, there is a risk that undue emphasis on innovation and spin-out will be at the expense of longer term basic research. This is already evident, for example, in the Ministry

of Defence. The 1999 Forward Look showed that although MOD's overall expenditure of SET will increase by 3.2 per cent over the next three years, there will actually be a cut of 13.2 per cent in research spending. The danger here is that although there may be clear short term benefits from the focus on development activities, the underlying knowledge pool of the organisation will be reduced and that capability will not be sustained over the longer term. It is also worth noting that opportunities for technology transfer often arise as unintended consequences of basic research. Unless the research base is maintained and strengthened, future development activities will depend increasingly on buying in research outputs from elsewhere.

8. Moreover, experience has shown that moves to contractorisation and privatisation of research have tended to reduce interchange of ideas and to lead to less, not more, flexible relationships between the science base and industry. There are added difficulties in relation to the privatisation of defence research, as detailed in the DERA Trade Unions Response to the MoD consultation document "A Public Private Partnership for the Defence Evaluation and Research Agency". Representation of scientists in government must be increased, in policy-making roles as well as the delivery of science, to provide continuity of expertise and intelligent decision-making and to act as a flexible resource in times of crisis. The 1993 White Paper said that "Government recognises that science and technology are integral to the missions of many departments, and that changes should strengthen the effective provision of scientific expertise and advice". In fact the post-White Paper policy of privatisation of PSREs has severely weakened that provision and unfortunately, the general prescription in the Baker report that public sector research establishments should be put at greater arms length from government departments is likely to continue that process.

9. Consideration also needs to be given to the level of funding and the way in which it is allocated. Despite recent welcome increases in government funding, more money is still needed for scientific research and innovation particularly at departmental level, as highlighted in the Select Committee's own report on "Government Expenditure on Research and Development: The Forward Look". The funding modes used by Research Councils foster a highly competitive system in which academic reputation is both the key to the door and the main outcome. Whilst publication of scientific papers is a good outcome for the staff involved, a system geared mainly to judgements of academic excellence makes it very difficult to build in applied aspects of research at an early stage. Crucially, at the time of conception of new programmes of work the ideas, however exciting, can be of little direct relevance to industry. The inclusion of user community members on steering committees and review panels is useful, but not as effective as full consultation with industry groups to define the scope and aims of work in the subject area. The challenge will be to maintain scientific rigour, while accepting that users will want to "call the tune", especially when they are making a financial contribution.

10. A recent IPMS membership survey of members employed in research and development clearly showed the stresses and strains that can result from reliance on external funding. Respondents were asked a series of questions designed to gauge the impact of increasing contractorisation and commercialisation of public sector research work. For example, they were asked whether they had ever been asked to tailor their research conclusions or resulting advice. 70 per cent had not, but of the remaining 30 per cent:

- 17 per cent had been asked to tailor their work to suit the customer's preferred outcome;
- 10 per cent had been asked to do so in order to obtain further contracts; and
- 3 per cent had been asked in order to discourage publication.

11. The role of the science base in underpinning developments across a wider range of scientific disciplines has not been fully appreciated, either politically or in funding terms. For example, the National Space Strategy recognises that "the facilities and infrastructure managed by public sector organisations constitute a valuable resource in the development of future commercial and operational systems outside their core policy sectors". Recent practical applications of space science including satellite communications, mobile phone applications, and improved weather and climate forecasting, are of major commercial value. The Government needs a strategy on "big science", of which space science is an integral part, including the role of international collaboration. IPMS is concerned, in particular, to retain in the UK engineering base skills located substantially in the Particle Physics and Astronomy Research Council (PPARC) and the Council for the Central Laboratory of the Research Councils (CCLRC). The technical infrastructure and staff skills must be sustained for the benefit of the economy as a whole.

Reorganisation of Research Councils

12. Research Councils have been subject to a process of almost continuous review since the 1993 White Paper, which itself generated some major changes in organisation. One example is the formation of CCLRC, whose Daresbury Laboratory (DL) and Rutherford Appleton Laboratory (RAL) were formerly part of the Science and Engineering Research Council (SERC). On dissolution of that body, they were transferred first to the Engineering and Physical Sciences Research Council (EPSRC) and then, on 1 April 1995, to the Central Laboratory of the Research Councils. This reorganisation generated a series of problems, some of which are still continuing. For example, CCLRC funding is drawn primarily from the other Research Councils. Universities are the main competitors for this funding and because they are also able to obtain finance from the relevant Higher Education Funding Council, appear to offer a cheaper service than CCLRC. As a result some CCLRC projects are under threat. One recent casualty has been the Particle Physics Theory Division,

much of whose work has been transferred to a university. On the organisational front, the loss of the SERC central office in Swindon has resulted in many HQ functions being located at RAL, with the result that many DL staff perceive their site as an establishment of RAL rather than of CCLRC. This was evident during the recent campaign over the siting of the new synchrotron source. The decision to site it at RAL confirmed the worst fears of many at DL.

13. Despite the fact that there is no need for further change Research Council institutes now face the prospect of another round of Prior Options Reviews. Added to this, although some areas fared well as a result of the 1998 Comprehensive Spending Review, there have been continuing pressures on research budgets and the continuing necessity to spend significant amounts of time bidding for external funding. A number of research institutes have had to cope with staff redundancies and more are in prospect, including the large scale job losses at CCLRC's Daresbury laboratory. It is in this context, which understandably has generated considerable cynicism about new initiatives, that new mission statements have been introduced. Having said this, there is no doubt that greater attention is now being given to opportunities for commercial spin-off and exploitation of intellectual property rights. Some progress is being made on how these issues should be managed, and IPMS continues to contribute to initiatives developed by the Office of Science and Technology (OST) in response to the Baker study. However, there is no doubt that more work needs to be done, for example in relation to action to be taken to resolve conflicts of interest and in provision of best practice guidance. Indications from latest consultations are that these issues are now being addressed.

Creation of the post of Director-General of Research Councils and of the Office of Science and Technology (OST) to absorb Advisory Board for Research Councils functions

14. The initial formation of the OST was a welcome development. However there is still a need for the co-ordination of science across government to be strengthened. In practice the OST and Chief Scientific Adviser tend to be involved primarily with the Science Budget and the Research Councils, leaving very little resource for issues facing other departments and the Government as a whole. The Department of Trade and Industry (DTI) should appoint its own Chief Scientist rather than relying on the fact that the Chief Scientific Adviser is located within the department. This would not only help the OST concentrate on cross governmental issues, it would also be a vital step in building up scientific expertise in the DTI itself. This has been greatly depleted both by privatisation of all its major scientific public sector research establishments (PSREs) and by the radical reduction of scientific staff and their status in the core department. The Director-General of Research Councils (DGRC) needs to be able to draw more easily and directly on independent expertise, as envisaged in the 1993 White Paper. Consideration should again be given to establishing a standing group, including economic, industrial and management expertise as well as scientific know-how. At the same time, OST should consider increasing the number of secondees with university, industry and research council experience into its own senior positions.

Campaign to improve public understanding of science

15. It appears that public confidence in scientific experts is continuing to decline at a time when the need for high quality scientific advice for decisions in a wide range of policy areas of increasing complexity and uncertainty has never been greater. It is against this background, that IPMS welcomed the decision by the Chief Scientific Adviser to publish guidelines on the use of scientific advice in policy making. The draft "Guidelines 2000 on Scientific Advice and Policy Making" are a useful further step forward although we are concerned that:

- The role of the OST in co-ordinating and monitoring cross-departmental issues should be strengthened; and
- Monitoring reports should be included in the annual Forward Look; and
- Ministers should be made aware of shortages of resources for research that inhibit full adherence to the guidelines.

16. There is little point in engaging in public consultation unless the results of consultation processes are taken into account in decision making. Scientific assessment must inform policy decisions, but not pre-empt them. However at present much public opinion tends to be led by immediate concerns, and often those that are brought to attention by media reporting or by groups with a vested interest. It is to be expected that the commercial sector will respond to these opinions, as it has done in the case of GM foods, as there is likely to be a direct financial impact on their activities. However, publicly funded science has a wider and longer term role, providing both basic research for which there may be no prospect of commercial return as well as essential health and safety monitoring and data collection, for example in relation to climate change.

17. Restriction of day to day research decisions in this arena would not generally be a productive course though where there is a strong public interest, for instance relating to the ethics of a particular course of action, a lay input to decision making would probably boost public confidence. It would also place more firmly the responsibility for scientific development into the wider domain, thus making it less easy to use scientists as scapegoats. There needs also to be better communication of the priorities set in order to promote understanding of timescales and key milestones. Public sector science priorities will inevitably also reflect

government objectives and budgetary restraints. So, whilst public opinion should be given due consideration in setting the public science agenda, there are other factors that need to be taken into account in determining priorities. Policy decisions must be practical and take account of wider circumstances.

18. The recent House of Lords report on "Science and Society", to which IPMS submitted evidence, gives a useful exposition of the key challenges and possible ways forward. As indicated below, there needs to be a willingness to try new approaches and to build on existing successful initiatives, both at national and local level. For example, following its successful conference on plant biotechnology the Biotechnology and Biological Sciences Research Council (BBSRC) has organised a number of public discussion meetings. The fact that researchers funded by BBSRC are required to devote time to promoting public understanding of science gives a useful signal that activity in this area is regarded as important. The development of the World Wide Web provides significant new potential for initiatives to improve public understanding and awareness of science.

Application of science, engineering and technology to wealth creation and quality of life

19. As already indicated, IPMS supports initiatives to improve technology transfer, though we firmly believe that this cannot be the only driver for science strategy. It was both very disappointing and damaging that after the publication of the 1993 White Paper the then Government sought to pursue this objective primarily through an explicitly pro-privatisation agenda. Although the environment has changed for the better in many ways, the indications are that the diverse nature, functions and operational status of public sector research establishments are still not fully appreciated. Hence, for example, the failure of the Baker report to substantiate the recommendation that departmental PSREs should be moved to greater arms length from sponsoring departments.

WHETHER THE OBJECTIVES AND THEMES OF THE 1993 WHITE PAPER REMAIN APPROPRIATE TO THE DEVELOPMENT OF A STRATEGY FOR SCIENCE, ENGINEERING AND TECHNOLOGY AND, IF NOT, WHAT OTHER THEMES AND OBJECTIVES WOULD BE MORE BENEFICIAL:

20. Key themes of the 1993 White Paper are still relevant and useful. Improved communications between research providers and users is of key importance in ensuring that the science base is exploited to the benefit of the UK economy. However, not all objectives have been delivered and some need to be viewed in a new context. Key themes for the 21st century include:

Funding

21. An increase in the level of funding is required to ensure the key role of science in underpinning a successful knowledge-based economy. The injection of funds in the Comprehensive Spending Review was very welcome, though its emphasis was very much on addressing deficiencies in existing science infrastructure rather than on funding research programmes. Furthermore, more recent evidence shows that there is still a pressing need for higher investment. A study published in May 2000 by the Science Policy Research Unit found "compelling evidence of an investment gap between the UK and leading OECD countries in their support for publicly funded research". Another May 2000 report, by Manchester University's Policy Research in Engineering, Science and Technology concluded that the Joint Infrastructure Fund (JIF) is falling far short of what is needed to address universities' most urgent requirements for laboratory equipment. The February 2000 report of the CST on "Technology Matters" also expressed concern about inadequate government and industry investment in R&D and the need for clear career paths and prospects to boost the supply of adequately qualified science, engineering and technology staff.

22. Within the research council sector, a report from a joint EPSRC/PPARC panel has raised concern that lack of funds threatens both the provision of essential equipment and the supply of talented new physicists. According to the panel "Research infrastructure (both equipment and human resources) has been in decline for many years and may be reaching a critical point". At the same time long term review of its own science by PPARC concluded that because of intense pressure on budgets some first rank science will not get funded. There may be scope for joint development of such facilities by Research Councils and university departments if an appropriate funding mechanism could be identified. Allowing Research Councils to be involved in joint bids for a future round of the Joint Infrastructure Fund (JIF) may be one way forward.

23. Attention must also be given to the purpose and destination of SET expenditure and to the interrelationships between organisations commissioning research and their contractors. Experience in recent years in which cuts in departmental expenditure have resulted in withdrawal of support from contractors and unplanned shuffling of research programmes to meet short term political priorities is highly damaging. Research cannot be turned on and off like a tap and requires long term commitment of funds. The British Geological Survey, for instance, has recently presented evidence of the detrimental effects on key areas of research of the focused demands of commercial contracts combined with a long, gradual squeeze on science budget funding. Areas affected include monitoring of radon gas emissions and research into radioactive waste disposal, for which funding was withdrawn on termination of the Sellafield public inquiry. The Select Committee's own report on "Government Expenditure on Research & Development: The Forward Look"

recognises that MAFF's short term approach to funding is harming the science base in the UK. This is not to argue that research programmes should not adapt to changing circumstances, but this should be on a planned and consultative basis. To achieve this, there needs to be a better balance between core and contract funding and a redirection of government policy to bring core funding close to at least 60 per cent of the total. This is essential to maintain the quality of the science base and to ensure that the best scientists are able to develop their own ideas.

Staff

24. In parallel to moving towards a more stable regime, the short term approach to employing and developing staff needs to be changed. The need for urgent action is evident from the responses to IPMS' R&D survey. In this context it is also worth considering how their experiences and attitudes have changed over the past decade. Compared with a similar IPMS survey in 1991, a greater proportion of respondents are dissatisfied with their training and career development as well as with opportunities to publish research and influence the nature of their work. 30 per cent are looking for employment outside science, engineering and technology—double the proportion in 1991—and one half would not advise their children to follow a career in this field, up from 31 per cent in 1991. A much higher proportion of women than men want to move out of SET (47 per cent of women, 28 per cent of men), which emphasises the huge task that still needs to be done to improve women's employment prospects in this area. These are not just idle whinges from employees wanting better pay: they represent very real concerns about the future of a vital sector of the economy.

25. Work done by the Science Alliance (a campaigning group of trade unions in science—IPMS, MSF, AUT and NATFHE) shows that although the UK is at the top of the international league in producing science graduates per thousand in the labour force, it is bottom of the league in the percentage of 35–54 year old workers employed as professionals in physical and engineering science, life science and associated sectors. This is despite wide acceptance of the close correlation between the amount invested in R&D and long term growth and prosperity. The emphasis on contract research within the public sector and, associated with this, the employment of scientists on fixed term contracts, has made it more difficult to build up a stock of knowledge "capital" and less likely that researchers will reveal for further development any research spin-off that is not strictly within the terms of the contract. Instead of investing in this capital, research institutes have been encouraged to use staff as a flexible resource. The Dearing Report recognised the problems caused by making appointments on short term contracts, noting that ". . . the quality of research could be undermined if these researchers do not have a more secure career". Some progress has been made in the wake of the 1996 Concordat on career management for contract research staff in universities but, as shown by the second report of the Research Careers Initiative, there is still much more to be done.

Science Strategy

26. Recent developments, for example in the biotechnology and space sectors, have highlighted the need for sectoral approaches as well as an overarching science strategy and for better mechanisms to communicate national science priorities to these groups.

The recent report into "International Perceptions of UK Research in Physics and Astronomy" supported by the Institute of Physics is instructive in this regard, in particular the conclusion that although UK astronomy and physics are currently holding their own at the cutting edge that scientific strength rings hollow in some critical aspects. Similarly, the recent growth in biotechnology companies in Germany is a sign that the UK's current leading position may be under threat. IPMS is especially concerned to retain in the UK engineering base skills which underpin developments in a wider range of scientific disciplines, including biotechnology. Although the Foresight programme does provide a framework for considering these type of developments, it is also clear that it does not always lead to decisive action or the support that is needed from Government. For example, the considerable overhead costs in setting up well-found laboratory facilities capable of providing a focus for large collaborative projects are difficult to meet from current budgets. Better account also needs to be taken of multi-disciplinary projects, for which long term planning and resource commitment is essential.

27. Science strategy also needs a stronger regional dimension. It is important to provide a critical mass of scientific activity regionally and locally and to build up links between universities, PSREs, regional technology organisations and local business. This was illustrated most starkly in relation to the decision over the location of the new synchrotron source. Although the DTI has announced a £25 million science fund for the north west of England, this is very much by way of compensation for not being chosen to host the new synchrotron and will not be enough on its own to maintain the centre of excellence already established at Daresbury. Furthermore there is a danger that this kind of approach may simply fragment funding further. What is actually needed is a strategic approach that builds in regional considerations as part of the decision-making process. The present concentration of scientific facilities and expertise around Cambridge and around Oxford and the south east is not compatible with Government policy on sustainable development.

28. Neither should the impact and implications of devolution be ignored. The decision of the Scottish Executive to establish a high level advisory body to steer science policy in Scotland is a useful step forward, though is it clear that there is still much work to be done to make sure that the work of this body is integrated

into key decision making processes. The fact that a significant proportion of public sector science in Scotland is not financed directly by the Scottish Executive may make this task more difficult. IPMS is currently consulting members in Scotland on the report of the Science Strategy Review Group.

29. Achieving a "joined up" approach to science policy also requires a broader perspective. Much R&D is increasingly global in its implications. For example, it is clear from on-going debates about climate change and about genetically modified organisms that key aspects of science have a global impact. These issues have moved rapidly higher up the political agenda since 1993, and it is clear that future developments will be largely determined in the international arena. This is true also of aspects of energy policy, where key challenges are market liberalisation and radioactive waste management. Infrastructure requirements for "big science" are likely to be met only through international collaboration. Whilst there are already established fora for dealing with international and global issues, in future these will need to be more flexible and responsive to emerging developments and to proceed on the basis of wider consultation and involvement.

30. If, as seems likely, the emphasis on technology transfer and commercialisation is to be continued, further work is needed to ensure effective management of intellectual property, both for the scientists who generate it and to safeguard investment from the public purse. As outlined in our response to the Baker report, IPMS is keen to ensure that the desire to exploit innovation does not lead to the loss of key personnel from research institutes. We believe that the UK should learn from experience overseas and that government should take a leading role in promulgating best practice, including that already emerging in its own research institutes. For example, BBSRC's Business and Innovation Unit has developed expertise on intellectual property and is able to advise its research community. Hence there has been a marked increase in industrial consultancies, involvement in LINK, intellectual property held and exploitation income generated in BBSRC sponsored institutes over the last five years. The new guidance produced by OST is a useful starting point, though it will be important to monitor its impact in practice.

31. The Government will also need to take on board the findings of the National Audit Office inquiry into the exploitation of publicly funded research at the Roslin Institute. Furthermore, British contributions to design and development of international facilities raise questions about intellectual property rights (IPR) which have yet to be addressed. There are, for example, potential wider benefits from the work at CERN which have not been exploited due to an absence of ground rules. This may become a significant problem if the recommendations of the Baker Report are to be implemented in the generation of spin-off benefits from a space programme.

WHETHER ATTEMPTS TO DELIVER PROPOSALS OF THE 1993 WHITE PAPER HAVE RESULTED IN A CULTURE CHANGE ACROSS, OR IN PARTS OF, THE SCIENCE, ENGINEERING AND TECHNOLOGY BASE, AND, IF SO, WHAT IS THE NATURE OF THIS CHANGE AND HOW HAS IT BEEN DEMONSTRATED

32. There have been many changes across large parts of the science community, though it is worth noting that culture change tends to occur over a long period and is most successfully embedded with the support of the community to which it relates. The context as far as science, engineering and technology is concerned, is one of continuing change. However, the changes that have occurred have not always been along the lines of the 1993 White Paper and some unforeseen developments, such as the BSE crisis, have undoubtedly caused major shocks to the system. One of the key problems remains the propensity of politicians and other opinion formers to treat scientists either as infallible oracles or convenient scapegoats. Thus, despite a stated desire and some initiatives to open up scientific decision-making to wider public scrutiny, the perception still being fostered is that government science operates on an exclusive basis, primarily for the benefit of industry and Ministers.

33. Culture change in this setting of distrust requires a more sophisticated and open approach to consultation and information sharing. The Chief Scientific Adviser's forthcoming new guidelines on the use of scientific advice in policy making should help, as should some of the changes being made to established advisory structures and new approaches to consultation. However, it also needs to be borne in mind that the "blame" culture conveniently adopted by some politicians can easily negate the benefits of initiatives to foster openness. Furthermore, a culture of continued cost cutting and of politically expedient shifts in research priorities is hardly likely to engender a climate in which scientists respond positively to new challenges. On a purely pragmatic note, efforts to promote public understanding of science require appropriate resourcing. Many public sector scientists work to objectives that are tightly focused on contract delivery. A more systematic and well resourced approach that is not dependent on the goodwill of selected individuals needs to be built into the core mission and objectives for all public sector science.

34. IPMS' R&D survey provides a good indication of where culture change has occurred since 1991, when a similar survey was undertaken. As already indicated, respondents had generally become more dissatisfied both with working in public sector science and about their own career prospects. In relation to the R&D undertaken, there is no doubt that pressures to commercialise have made a difference in some areas though there is uncertainty at this stage how the creation of spin-off companies from public sector research establishments will affect public sector science. One fifth of respondents expected a positive effect compared with one third who expected negative consequences.

35. Potentially positive aspects were considered to be:

- Opportunity to apply research results;
- Additional/alternative source of income;
- Assist uptake of research and technology transfer;
- Success may breed success and increase investment in public sector research;
- Promote useful collaboration;
- Not bound by Treasury rules on financing;
- Tangible indicator of value of science.

36. Potentially negative consequences identified were:

- Impartiality called into question;
- Fragmentation of public sector science;
- Potential conflicts of interest for scientists and research establishments;
- Cream off profitable areas of work but less resources and time for basic and speculative research;
- Loss of in-house scientific expertise from public sector and of scientists' time for core aspects of job;
- Short termism;
- Restrict collaboration across institutes.

37. A large majority of respondents believed that the limited duration of project funding interferes both with the quality of science and restricts opportunities for further development of results. Four out of ten respondents believed that privatisation had made a difference to tendering independent advice in the public interest. Other respondents commented that they had not been asked for advice since their organisations were privatised. A number characterised their situation as "he who pays the piper calls the tune" or "state the truth and lose your funding". Respondents were asked about the "intelligent customer" capability of their sponsor department or, in other words, about the sponsor's ability to make well informed and timely decisions about its research requirements and use of research results. Typically this depends on having scientifically literate advisers and decision-makers within core departments. In practice, the legacy of privatisation and the rise of the contract culture is that 41 per cent of respondents considered that the "intelligent customer" capability of their sponsor department had become worse over the last five years. At the same time, one in five respondents reported that more than half their work is done on a "commercial in confidence" basis.

THE GOVERNMENT'S RECENT CONSULTATION ON SCIENCE AND INNOVATION STRATEGY STATED THAT "THE AIM IS TO USE THE UK'S EXCELLENCE IN SCIENCE TO ACHIEVE IMPROVEMENTS IN OUR NATIONAL INNOVATION PERFORMANCE AND SO TO IMPROVE THE COMPETITIVENESS OF THE ECONOMY AND THE QUALITY OF EVERYONE'S LIFE". DO YOU AGREE THAT THESE ARE THE APPROPRIATE AIMS FOR A NATIONAL STRATEGY FOR SCIENCE?

38. IPMS' response to the Government's consultation paper is at Annex 1[1].

WHAT DO YOU BELIEVE SHOULD BE THE MAIN FEATURES OF A MODERN STRATEGY FOR SCIENCE, ENGINEERING AND TECHNOLOGY AND WHY?

39. As stated above, IPMS believes that the 1993 White Paper still provides a useful framework from which to build though there are now also some new themes and objectives that need to be taken into account. The Government's recent consultation on "Science and Innovation Strategy" was a useful step forward in this regard though, as indicated in our response to it, we are keen that objectives should not be too narrowly focused. We are very firmly of the view that, in addition to delivering on specific goals, greater priority needs to be given to improving the science infrastructure—in particular to properly value the contribution made by scientists, engineers and technologists and to enhance career prospects and status. Enhancing public understanding of science is also crucial and this requires high level political commitment and a willingness to try out new approaches and address difficult issues in a more open and constructive manner.

8 June 2000

Notes:

1. Submission to the House of Commons Select Committee on Science and Technology inquiry into "The Prior Options Review"—October 1996

2. "Creating Knowledge, Creating Wealth—IPMS Response to the Baker Study into the Economic Potential of PSREs"—October 1999

3. "Consultation on the Next Round of the Foresight Programme"—July 1998

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[1] Not printed.

4. Submission to the House of Commons Select Committee on Science and Technology inquiry into "The UK Scientific Advisory System"—May 1998—and the inquiry into the "Scientific Advisory System for Genetically Modified Foods"—March 1999

5. Submission to the House of Commons Select Committee on Trade and Industry inquiry into "Aspects of Energy Policy"—January 1998

6. DERA Trade Unions Response to the MoD Consultation Document on "A Public Private Partnership for DERA"—June 1999

7. "What Future R&D?"—November 1999

8. Submission to the House of Lords Select Committee on Science and Technology inquiry into "Science and Society"—May 1999

APPENDIX 6

Memorandum submitted by University of East Anglia, Norwich

Whilst we welcome the opportunity to contribute to the current call for evidence, our first comment is that calls for evidence are too short term in their focus. In order to inquire into and examine the impact of the "Realising our Potential" White Paper, a long term evaluation would be more appropriate.

We would agree that closer relationships have been fostered between the public sector's investment in research and charities eg The Wellcome Trust involvement with JIF and University Challenge with the Gatsby Foundation; the support of charities in these areas has been welcomed. However, there are still issues relating to infrastructure under the dual funding system whereby research funding from charities is not effectively supported by the dual funding system except in top rated science departments. Overall QR only provides 13 per cent towards charitable income whereas the real indirect costs of Universities will be of the order of 80 per cent or more and Research Councils provide 46 per cent of staff costs. The dual funding system is an important part of our infrastructure but a clear concordat and consistent funding methodology is still required and has not been delivered, (paragraphs 8.2 and 1.18.8).

The changes envisaged to postgraduate training (eg Masters as normal entry into postgraduate research) are only now being pursued seriously and have not yet been fully implemented. Therefore the effect on "Realising our Potential" cannot be evaluated, (paragraph 1.18.12).

Finally, in seeking to ensure the efficiency and effectiveness of government-funded research, effort needs to be made to target public funds to those areas where private funding is failing. Public funds will not then be duplicated by private funds on the same area whilst other areas face under-investment, (paragraph 8.2).

I hope that these comments are of use to you. Should you have any queries, please do not hesitate to contact my colleague Mr John Brind in the Research and Business Development Office.

12 June 2000

APPENDIX 7

Memorandum submitted by the Higher Education Funding Council for Wales

INTRODUCTION

1. The Higher Education Funding Council (HEFCW) is responsible for the administration of funds made available by the National Assembly for Wales in support of the provision of education and the undertaking of research by higher education institutions in Wales. Its interest in the Science and Technology Committee's inquiry stems from the Government's commitment to a dual support system for research carried out by the higher education sector. The overall purpose of the research funding provided by the Council is to enable the maintenance and development of a flexible and dynamic high quality research base in Wales, thus complementing the funding made available by the Research Councils for individual projects.

OBJECTIVES OF THE 1993 WHITE PAPER, REALISING OUR POTENTIAL

2. The Government's strategy in the White Paper was to improve the nation's competitiveness and quality of life by maintaining the excellence of the United Kingdom's research capability. High profile was given to the role of science and technology in the economy. The importance of technology transfer (ie a greater accessibility of research results from the science base to industry) was stressed, as was the need for the science base and for those providing public funds in support—the Research Councils and the Funding Councils—to take into account the needs of industry in forming priorities.

HEFCW Response

3. Although the White Paper did not call for radical changes in the structure and operation of the Funding Councils, its published aims have become manifest in the objectives of HEFCW and have been reflected in the way that institutions in Wales have responded.

4. HEFCW's monitoring of institutions shows a marked change in attitudes. There is much more emphasis on actions in support of wealth creation, exemplified for instance by increased income from contract work. HEFCW has sought to encourage these activities through a number of funding initiatives and is now moving towards a permanent funding stream in support of contract work and other programmes, including those allied or akin to research conducted with industry and commerce (so-called "third leg" funding). Likewise, the Council works in partnership with the Welsh Development Agency on initiatives designed to support the aims of the White Paper.

5. In this context, the Committee should note that the Funding Councils have built the White Paper agenda into successive Research Assessment Exercises. Thus, HEFCW's conclusion is that the White Paper's objectives and themes have led to a culture change, and that they remain appropriate to the development of a strategy for science, engineering and technology, from both the national and territorial standpoints.

6. In terms of the Government's plans for achieving its objectives, HEFCW endorses the agenda set out in para 4. Bullet points 3 (streamlining knowledge transfer schemes and focusing them on clearer goals) and 4 (fostering regional networks) are matters of particular relevance to the National Assembly for Wales, and HEFCW's role in maintaining a research base that will support the Welsh economy. The Assembly has made available a budget of £15 million over 2000/01 and 2001/02 for the Knowledge Exploitation Fund, intended to give added impetus to collaboration between business and higher education.

7. HEFCW is also currently conducting a review of its policy and mechanism of funding research. This will feed into the Assembly's review of higher education taking place in the Autumn of 2000, in which exploitation of the research base is likely to feature as a major priority. In this context, the operation of the next round of Foresight with a stronger regional dimension will be of significance, as it seeks to identify priorities of specific relevance to Wales.

8. A point made strongly by sector institutions in responding to HEFCW's consultation on research policy (February 2000) was that support for a research base that contributes to quality of life in its broadest sense is often overlooked in concentrating on economic competitiveness. It might be appropriate to make specific mention of quality of life issues in the plans put forward to achieve the Government's aims.

12 June 2000

APPENDIX 8

Memorandum submitted by the Association of Veterinary Teachers and Research Workers

AVTRW is the largest organisation representing research workers, not exclusively veterinarians, involved in veterinary research in the UK and Ireland. We also have some European members. We are pleased to respond to the call for evidence and would welcome the opportunity to present oral evidence.

Veterinary research comes through as one of the most internationally competitive areas of British research in recent analyses. It is also inherently involved in work intended to find commercial application, whether in veterinary practice, public health (control of zoonoses), food hygiene, the pharmaceutical industry, or other sectors, such as the bloodstock industry, which are dependent on the health of animals.

There is a crossroads in veterinary research, not simply because we are in a new millennium, but because the Selborne Report on Veterinary Research has identified problems requiring solutions and created a climate of change and, in addition, the centre of gravity of veterinary activity has moved from farm animals to companion animals and horses.

In the original Technology Foresight programme we were keen to ensure that veterinary research should be aligned with life sciences, in view of the growing importance of comparative medicine and the prevention and control of zoonoses. Accordingly our nominee (Prof Michell) sat at meetings of the Health Services Panel. Despite recommendation from us and from the chairman of that panel, representation has been lost in the transition to the new panels under the current Foresight programme. Granted the importance of the subject, both to the community and to British industry, it seems strange that veterinary medicine has been marginalised in the current programme and that this important area of British research enterprise has lost its link to national scientific policy development.

Restoration of that link is pre-eminently important at this time. This is emphasised not only with regard to commercial opportunities, but to areas of public concern such as the transmissible spongiform encephalopathies and development of antimicrobial resistance. Our scientific understanding of these issues would have benefited from closer alignment of veterinary and medical expertise.

In our wider national responsibilities, the importance of veterinary medicine in solving the problems of equating food supply with food production in disadvantaged areas was well illustrated by the recent award of the International Food Prize to a distinguished veterinary scientist, Professor Walter Plowright, FRS."

12 June 2000

APPENDIX 9

Memorandum submitted by Professor A R Michell, President Royal College of Veterinary Surgeons

Veterinary science is an area in which this country has made an exceptionally strong contribution and this continues. While the traditional perception of veterinary medicine relates to its role in agriculture, change has been rapid in recent years and the great majority of veterinary activity now relates to companion animals and horses.

Veterinary science is, intrinsically, applicable and relevant not only to the agricultural and food production industries but to the network of SME's represented by veterinary practices, and the industries (pharmaceutical, surgical supply etc) which depend on their success.

Scientifically, the key role for veterinary research has become its relevance to public health (zoonoses, food safety) and to comparative medicine, the lessons for human disease which can be drawn from relevant models in domesticated species, notably dogs and cats. A closer alignment between the research interests of human and veterinary medicine has been a key objective of this organisation in recent years.

It was, therefore, highly appropriate that there was a veterinary representative at the meetings of the Technology (Foresight) Health Sciences Panel and it is a matter of regret that this is no longer so with its successor. We would urge that similar representation is restored otherwise an important area of applied biomedical science, in which Britain is strong, is left in limbo with regard to this key dimension of national scientific policy development, with its particular emphasis on the interface between research and its commercial potential. This is certainly a decisive time for veterinary research as we move towards implementation of the findings of the Selborne Report, assisted by the Chairman of HEFCE (Sir Brian Fender).

9 June 2000

APPENDIX 10

Memorandum submitted by the Save British Science Society (SBS)

WASTED POTENTIAL

1. SBS is pleased to respond to this consultation on developments in science policy since the last Science White Paper in 1993. SBS is a voluntary organisation campaigning for the health of science and technology throughout UK society, and is supported by 1,500 individual members, and some 70 institutional members, including universities, learned societies, venture capitalists, financiers, industrial companies and publishers.

2. This response follows the format of questions in the call for evidence. SBS regrets that the unavoidably wide ranging and general nature of the inquiry mean that our response cannot be short. Many of the issues have been dealt with in previous SBS documents, and where this is the case, we have appended the relevant document rather than reiterate the same information.

Q1. THE EXTENT TO WHICH THE OBJECTIVES SET OUT IN THE 1993 WHITE PAPER HAVE BEEN DELIVERED

3. The 1993 White Paper does not in fact explicitly set out a list of objectives, although it does set out 13 "specific policies", each of which is dealt with in turn below.

Policy 1—Openness

4. In general, SBS believes that significant progress has been made in this area, although the lack of openness surrounding the siting of the new synchrotron was a retrograde step. Our views on the Forward Look are set out in our response to the Committee's previous inquiry into overall levels of government investment in science. Our views on openness in the use of scientific advice are set out in our response to the Chief Scientific Adviser's consultation on the implementation of his Guidelines[2]. Copies of these responses are appended.[2]

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[2] Not printed.

Policy 2—Technology Foresight

5. SBS's view on Foresight were summed up in our response to the consultation on the second round of Foresight, a copy of which is appended[3]. Our principal concerns remain (i) that Foresight must not become too prescriptive in determining which projects should be funded in the science base, and (ii) that the level of personnel involved in interactions between different communities remains too high—it is researchers at the laboratory bench, not always their Heads of Department, who might make valuable suggestions.

Policy 3–The Council for Science & Technology

6. The Council for Science & Technology has seen interesting developments in the past three years. Its work programme is realistic and interesting. We note, however, that apart from a DTI press release, no new press release has been posted on the CST's website since December 1998, although, of course, two interesting reports have been posted.

Policy 4–Technology Transfer

7. The process of technology transfer has changed dramatically in the past seven years. The changes have come about largely through cultural shifts in universities and elsewhere, and these changes are discussed in answer to question 4 below.

Policy 5–Innovation Support

8. It is difficult to see how it can be true that it is easier for firms to access innovation support from the DTI and what were until recently the Scottish, Welsh and Northern Ireland Offices, when the level of relevant investment has fallen.

9. In the DTI in the current financial year, annual investment in science, engineering and technology is £168 million lower in real terms than it was when the White Paper was published in 1993, using published figures excluding launch aid. Using the figures that include launch aid, the overall level of annual investment has fallen by £113 million[4].

10. The fact that the Government's recent consultation[5] proposes the development of a Small Business Service suggests that it recognises the failure of this policy since 1993. SBS has welcomed the new service.

11. It is impossible now to comment on the Scottish, Welsh and Northern Ireland offices, since their functions in this area have been taken over by new bodies. SBS detects very positive indications on science and innovation, particularly from the Welsh Assembly.

Policy 6–The Research Councils

12. The creation of full-time Chief Executives of the Research Councils has been a positive step, bringing high-quality scientists into the science policy arena. The distribution of subjects among Research Councils is effectively a neutral decision, since interdisciplinary work is increasingly important, as was evident in the award of new money for research at the interface of biology and the physical sciences, invested in the Engineering and Physical Sciences in the 1998 Comprehensive Spending Review.

13. Focusing Research Council missions on wealth creation and quality of life has only worked because these objectives are seen by many on grant committees as secondary considerations to the quality of the science. In those instances where this is not the case, such focus is inappropriate for Research Council funding. Any attempts to increase the degree of focus would be unwelcome.

Policy 7–Director-General of the Research Councils

14. Few people doubt that the post of Director-General of the Research Councils was an asset in the 1998 Comprehensive Spending Review, when the then incumbent played a significant role in making the case for science.

Policy 8–Dual support funding mechanism

15. The dual funding mechanism remains crucial. It is not true, however, to say that it has been properly "maintained" as the 1993 White Paper set out. The proportion of funding for the science base that comes through the Funding Council side of the mechanism has continued to fall since 1993, following a trend that has been established since at least 1981[4].

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[3] Not printed.

16. The 1993 White Paper explicitly allowed that Funding Council money should be available for use "at the institutions' discretion". Most Vice-Chancellors and Heads of Department no longer feel that they can exercise this discretion fully, within current levels of Funding Council investment in research, and with the blurring of the boundaries between accountability to Government and control by Government.

17. The erosion of the Funding Council side of the dual support system is the root of the now well-known problem of poor salaries and poor career structures for researchers.

Policy 9–The customer-contractor principle

18. Privatisation of the Government laboratories cannot claim to have been an unqualified success, and, for example, the Government's current plans for the Defence Evaluation and Research Agency do no appear to have been formulated in the best interests of science policy. A briefing paper outlining SBS's views on this particular privatisation is appended[4].

19. More generally, the constant series of reviews, such as "Prior Options", "Efficiency Scrutiny," "Next Steps Agencies" etc., has made scientific advice to Government increasingly dependent on non-public, and hence somewhat partial sources of funding.

20. Good scientific advice to government must not only be impartial but be seen to be impartial, and SBS agrees with the Committee's recent report[7] that the cuts in research budgets of civil departments that have happened since 1993 have been deplorable.

Policy 10–Departmental co-ordination

21. Departmental co-ordination of scientific matters remains unacceptably poor. The Chief Scientific Adviser told the Committee in a recent evidence session that he has "relatively little impact" in some departments, and that in any case he has no "authority," merely an advisory capacity. At the same evidence session, the Science Minister was unable to deny the veracity of SBS's belief that "the Office of Science & Technology is powerless in the face of government departments that are under pressure" from elsewhere[8].

Policy 11–European and international science programmes

22. The fact that many researchers choose to apply for European funding only if they cannot obtain grants from other sources suggest that the EU's handling of scientific matters remains far from perfect.

Policy 12–Postgraduate training

23. Although there have been some welcome developments in post-graduate training (such as the growth of the MChem degree), the policy of proper underpinning has not in general been achieved. In many subjects, it remains the norm for students are expected to complete both a first degree and a PhD within a total of six years.

24. The draconian measures taken against departments whose doctoral students do not complete their PhDs within a short timescale are forcing universities to adopt practices that will further devalue the British PhD relative to those of competitor countries.

25. In most cases, it should be normal for an extra year to be included to bridge the gap between bachelor's degrees and doctoral degrees. In some cases, this may be best achieved by having a Master's level undergraduate course, in others it may be more appropriate to have a longer PhD. Either way, changes are needed to bring about the "proper underpinning" of PhD training that the 1993 White Paper expected. The Wellcome Trust's four year PhD, in which students spend a year working on small projects in different laboratories before making a final choice, is a model that is working well and is attracting many of the best students.

Policy 13–Public Understanding of Science

26. The current OST website says that the first round of public understanding of science grants is complete, and a second round will begin in the spring of 2000. This is welcome, but if the "campaign" alluded to in the 1993 White Paper had been taken as seriously as it should have, the grants scheme would not have taken six years to come into effect.

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[4] Not printed.

27. The concept of the "public understanding of science" is becoming outdated, with people beginning to recognise that "scientists' understanding of the public" and "public understanding of scientists" are equally as important. More properly, what is needed is an approach based on discussion and dialogue between scientists, a wider public, government and industry etc. The recent House of Lords report on Science and Society deals with this and many related points, and we append a copy of our evidence to that inquiry(10).

28. Perhaps the most important issue is for governments to be more open about admitting scientific uncertainty. Untrue platitudes about the safety of BSE-infected meat came from politicians, not from scientists, who warned in 1989 that there might be a risk to human health.

Q2. WHETHER THE OBJECTIVE AND THEMES OF THE 1993 WHITE PAPER REMAIN APPROPRIATE

29. The assumption in the 1993 White Paper was that the UK science base was excellent, and that it would, almost by default, remain so. Such problems as existed were said to be concerned with the application of the results generated within that science base.

30. This assumption is dangerous, because the quality of the science base is the fundamental policy on which everything else rests. Without an excellent science base, the thirteen policies outlined in the 1993 White Paper, and the "key principles" or "areas for action" in the current Government's science strategy consultation(5), are pointless.

31. The most appropriate objective for the White Paper that is currently being prepared is to reinvigorate the UK science base, with increased investment, better career structures and more scope for creativity and innovation. This would be the best way of delivering the fundamental aim of the 1993 White Paper—improved wealth creation and quality of life.

Q3. WHETHER ATTEMPTS TO DELIVER THE PROPOSAL OF THE 1993 WHITE PAPER HAVE RESULTED IN A CULTURE CHANGE

32. There is no doubt that the cultural change created by the 1993 reforms has been substantial.

SBS believes that, in current circumstances, the university sector has made as great a change in its approach as can be expected. As we set out in our response to the Government's consultation document on a science and innovation strategy(12), we believe that encouraging "industry pull" is now equally as important as "university push" in striving to ensure the economic benefits of UK science.

3.1 SBS's survey of recent grantholders

33. The fact that universities now focus on the economic and social benefits of their research are clear from SBS's survey of researchers who have been awarded grants under schemes created or developed following the 1998 Comprehensive Spending Review(13).

34. The survey covered the lead applicants on successful bids to the Joint Infrastructure Fund (JIF), as well as the Vice-Chancellors of all universities awarded grants by the JIF, University Challenge Fund, Higher Education Reach Out to Business and the Community Fund, and the Joint Research Equipment Initiative.

35. The 45 per cent of JIF grantees and 22 per cent of Vice-Chancellors who responded were unequivocal in their emphasis on the wealth creating and quality of life benefits of the work that is being funded. A substantial majority believed their projects would create wealth, and slightly more than half saw improved quality of life as a feature of their work.

3.2 Independent advice

36. Another shift in culture is very unwelcome. Universities used to be seen as independent, disinterested sources of advice on scientific issues, but there seems little doubt that this view is shifting. This might be inferred from the fact that people trust "Professors" more than they trust "Scientists"(14).

37. Continued pressure for private sources of funding of research is seriously damaging the perception of independence in some areas.

Q4. WHETHER THE GOVERNMENT'S CONSULTATION DOCUMENT SET OUT APPROPRIATE AIMS FOR A NATIONAL SCIENCE STRATEGY

38. SBS's views on the Government's consultation document are more fully set out in our response to the consultation, *Maintaining an excellent science base for the benefit of the UK's citizens,* a copy of which is appended to this response.(12)

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[5] Not printed.

[6] Not printed.

Q5. What should be the main features of a modern strategy for science?

5.1 Human resources

39. The single most important feature of any science strategy should be to ensure an excellent science base. Without this, no other policy is worth having.

40. An excellent science base can be created only with the right people, so the single most important indicator of the success of any science strategy is the quality of its people. This applies strongly not just to those currently holding senior positions, but also at lower levels, from which the future science base must be regenerated.

41. The evidence for the strength of the UK's science base is varied, and a great deal of it has been analysed and presented by the Chief Scientific Adviser[15]. Parts of the evidence are somewhat anecdotal, or based on statistics that are difficult to interpret, taken together, the body of evidence suggests that the UK remains among the stronger scientific nations for the time being.

5.1.1 Evidence of a Brain Drain

42. However, the evidence of problems for the future potential of the science base is also considerable. The recruitment and retention of high quality students, postgraduates, postdoctoral researchers and academic staff is proving increasingly difficult in many universities, with inevitable variation among subject disciplines.

43. The simplest demonstration of difficulties in recruiting and retaining top-quality researchers is the testimony of the university Vice-Chancellors, Deans, and Head of Department whose job it is to appoint researchers.

44. The Independent Review of Higher Education Pay and Conditions[16], carried out in 1999, surveyed universities and found that 98 per cent had experienced difficulties in recruiting academic staff. Moreover, for more than three quarters of the institutions surveyed, such difficulties were not rare. Almost 6 per cent experienced difficulties more often than not. The figures for the retention of staff were no less encouraging. More than 95 per cent of institutions had experienced problems in retaining staff, and such difficulties were not rare in more than 50 per cent of institutions. Although these figures apply across all disciplines, there is no reason to suppose that patterns of recruitment and retention in the natural and social sciences are atypical.

45. SBS is currently surveying Deans of Science in UK universities, and the preliminary results demonstrate that recruiting high-quality postgraduate students, postdoctoral researchers and academic staff is a significant problem in science departments.

46. Further evidence of a recruiting problem comes from the Biotechnology and Biological Sciences Research Council, which believes that the gap in remuneration between postgraduates studentships and the salaries the same young people could earn elsewhere is "making a significant impact"(17).

47. Anecdotal evidence collated for the Association of Researchers in Medicine and Science demonstrates that "the lack of an attractive career structure threatens [the] future [of research]".

48. A report by the Office of Manpower Economics found that recruitment was "becoming more difficult" in universities, prompting one newspaper to state that there was "a crisis over finding the professors of the future"(18).

49. In the industrial sector, the testimony of senior figures serves to show that difficulties in recruitment and retention of top-quality researchers are becoming greater. A single, clear example comes from the pharmaceutical company Pfizer, which employs 4,500 people in the UK. Its Director of Science Policy says that to compete in the global marketplace, "you need the best quality scientists, and we are increasingly finding that we're recruiting from mainland Europe"(20).

50. It is because the weight of evidence point unambiguously to a crisis in recruiting and retaining the best people in British science that SBS believes that the UK is wasting its potential.

5.1.2 Causes of the brain drain

51. The reasons for a haemorrhaging of the best brains from UK science are varied, but there can be little doubt that the salaries of researchers in British universities are no longer even remotely competitive.

52. Some European scientists say they look at the salaries offered in academic job advertisements in Britain "when they want a laugh," and a university in Canada is deliberately "targeting" UK universities in an effort to poach high-quality people in the knowledge that UK salaries are deeply uncompetitive(21).

53. Thus, a modern science strategy should aim to pay its researchers stipends and salaries that are commensurate with their abilities, and commensurate with their market value. In the words of the Chief Scientific Adviser during a radio discussion with the Director of SBS: "Could I just agree with Peter, we ought to pay people more"(22).

5.2 Investment

54. A modern science strategy should understand the value of investment. As the current Science Minister himself has said: "The more you put in, as a whole, the better." He further acknowledged that "Government investment in science is . . . not brilliant".

5.2.1 Building on past investment

55. A problem with a simple assertion that the science base is currently excellent is that it fails to acknowledge that current excellence is largely a measure of past investment. As the Chief Scientific Adviser has said, his own demonstration that UK science delivers more outputs per pound sterling investments than any other country is based on " a lot of building on past investment".

5.3 Exploiting knowledge

5.3.1 Economic exploitation

56. A modern science strategy should aim to exploit knowledge for the economic benefit of the UK's population. Many of SBS's ideas in this area are set out in our document *From the Laboratory Bench to the Boardroom: Creating Wealth from the Academic Science Base*(23), which followed a successful symposium in the City of London. A copy of that report, based on the views of academics, industrialists, financiers, government officials, entrepreneurs and others, is appended.[7]

5.3.2 Better government

57. Better government would come through a more effective use of impartial scientific advice by Government.

58. Such impartial advice can only come via proper investment in government science. We do not expand on this point, because the Committee inquired into this area in great detail in its recent report on government Expenditure on Research and Development.

59. This report quite properly stressed the lunacy of continually cutting departmental research budgets, as science and technology become increasingly important in policy making. It also made the eminently sensible recommendation that the Minister for Science should sit in the Cabinet.

60. In this context, we find it disturbing that the Science Minister recently used the word "marginal" to describe the cut of £40million per annum in civil science, engineering and technology that has occurred since the 1997 General Election. It is difficult to square the description of this three per cent cut as "marginal" in the same interview as an eight per cent increase in another parameter as "very substantial".

61. We disagree with one conclusion of the report. The Committee felt that SBS had not made a persuasive case for a Ministry of Science, on the grounds that "any attempt to create a central R&D budget would throw up more problems than it would solve". But our proposal specifically ruled out the creation of such a central budget, arguing that while the proposed Ministry would have "oversight of all government R&D" to avoid political interference in interpreting results, the individual ministries would "retain their own R&D budgets" and the "right to define the scientific questions that might be asked".

62. SBS persists in its belief that to avoid the kind of political interference that exacerbated the problems of Bovine Spongiform Encephalopathies (BSE), a central Ministry of Science is essential.

5.4 Scientific education and appreciation of science

5.4.1 Formal Education

63. At an SBS symposium on *Holding on to Excellence in British Science,* a report of which will be published shortly, a varied group of UK scientists identified major changes in the education system as a crucial part of the changes required to ensure UK excellence in science during the coming years.

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[7] Not printed.

64. For example, schoolteachers would benefit from the opportunity for sabbaticals, to allow them time and opportunities to keep up to date with rapidly moving developments.

65. Moreover, university-level teaching requires the same kind of kudos as attached to research.

66. An outline of SBS's position on changes required to PhD training is given in paragraphs 23 to 25.

5.4.2 Involving the public

67. The public mood matters. The disposal of the Brent Spar oil platform was an example of public opinion triumphing when it disagreed with the best scientific advice.

68. When the press and public appear to be turning against a new technology, a modern strategy for science would see the Government facilitating a proper dialogue. In this regard, for example, it was unhelpful when the Health Minister Lady Hayman was reported as saying that it was "not a safety issue" when 20,000 acres of crops with some genetically-modified content were planted by accident(24). The public remembers only too clearly being told by politicians that BSE was not a safety issue, only to find out that this was wrong. Thus, a policy of openness and honesty is essential, and in this regard SBS welcomes the Chief Scientific Adviser's Guidelines on the use of scientific advice in planning public policy.

69. The Government's role in involving the public in scientific debate should be considerable, although in fairness, this area ought also to be the concern of all scientific organisations.

NOTES AND REFERENCES

1. *World class investment in world class science, SBS*, 1999 [SBS 00/23]

2. *Better government through the highest quality scientific advice*, SBS, 2000 [SBS 00/03]

3. *Response to the consultation document on the next round of Foresight*, SBS, 1998.

4. *The Forward Look 1999: Government-funded science, engineering & technology*, OST, 1999 [Cm 4363]

5. *Science and innovation strategy: consultation paper*, DTI, 2000.

6. *The future of the Defence Evaluation & Research Agency*, SBS, 2000 [SBS 00/13]

7. *Government Expenditure on Research and Development: The Forward Look*, Fifth Report of the House of Commons Science & Technology Committee, Session 1999—2000 [HC 196-1]

8. Oral evidence to the House of Commons Science & Technology Committee, 25 May 2000.

9. *Science and Society*, Third Report of the House of Lords Select Committee on Science & Technology, Session 1999—2000 [HL Paper 38]

10. *The isolation of the scientist*, SBS, 1999 [SBS 99/15]

11. see the BSE website www.bse.org.uk

12. *Maintaining an excellent scientific base for the benefit of the UK's citizens*, SBS, 2000 [SBS 00/07]

13. *The benefits of recent investment in scientific research*, SBS, 2000 [SBS 00/15]

14. Seeking Consensus on Contentious Issues: Science and Society, talk by Robert M Worcester, Foundation for Science & Technology 12 July 1999.

15. *The Quality of the UK Science Base*, DTI, 1997.

16. Independent Review of Higher Education Pay & Conditions, Stationary Office, 1999, appendix E, tables 1 and 2

17. Talk at Heads of Biochemistry Departments Meeting, 4 May 2000.

18. ARMS Newsletter, January 2000, p.3.

19. *The Times*, 25 February 2000, p.10.

20. The Westminster Hour, BBC Radio 4, 4 June 2000.

21. SBS Newsletter, Number 26, July 2000.

22. The Learning Curve, BBC Radio 4, 21 March 2000.

23. *From the Laboratory Bench to the Board Room: Creating Wealth from the Academic Science Base*, SBS, 1999 [SBS 99/17]

24. Guardian, 18 May 2000.

June 2000

APPENDIX 11

Memorandum submitted by the Royal Astronomical Society

1. The Royal Astronomical Society is grateful for the opportunity to comment on your inquiry and our response is below. Please let me know if there is any further information you require.

2. The Royal Astronomical Society welcomed the creation of the Particle Physics and Astronomy Research Council, with a responsibility for supporting basic research in the subjects that come under its aegis. The UK has always played a leading role in Astronomy, and it is important that our internationally competitive position should be maintained. This requires that the science base should be adequately funded, with sufficient resources being made available to support blue-skies research. To remain competitive, UK astronomers must continue to have access to world-class observational facilities, in collaboration with research groups in Europe and the USA. The observational programme must also be backed up by access to high-performance computing facilities, both for handling data and for developing sophisticated theoretical models.

3. Astronomy continues to arouse considerable public interest and stimulates young people to choose careers in science. It is particularly important in attracting students to study physics, where there is a national shortage. Those who graduate or obtain PhDs in astronomy have a broad experience in IT, as well as in data-handling and modelling; many of them subsequently move into industry or financial services, where they can contribute directly to creating wealth.

June 2000

APPENDIX 12

Memorandum submitted by the UK Life Sciences Committee

The UK Life Sciences Committee (UKLSC) comprises 15 leading learned societies in the cell, molecular, and physiological life sciences and represents about 35,000 researchers in academia and industry. This response was compiled by asking member societies to indicate their agreement or disagreement with a series of possible views on the initiatives introduced in the 1993 White Paper, as listed in the Science and Technology Committee's call for evidence. It has been endorsed by all UKLSC member societies.

Are we Realising our Potential? General Comments

1. Statistics can be utilised to show that Britain's science, engineering, and technology (SET) base continues to punch above its weight in international competition. But there was unanimous agreement within UKLSC that we are not fully realising our potential, in particular with respect to renewal of the science base. There is a lack of investment in the salaries, career pathways, and opportunities for young people that is discouraging many of the brightest students from considering a career in science.

The Impact of the Annual Publication of Forward Look

2. There was a unanimous view that Forward Look is a useful source of statistics on government expenditure, but that its publication does not appear to have influenced government policy. For example, the Government has been criticised for allowing departmental R & D expenditure to decline whilst at the same time proclaiming its commitment to evidence-based policy making. UKLSC strongly supports the recommendation of the Commons Science and Technology Committee that Forward Look should seek to match published spending figures to previously announced policy objectives, so that it is more transparent how successful departments have been.

The Impact of Technology Foresight

3. UKLSC members agreed unanimously that there has been an increase in entrepreneurship and willingness to engage with industry among academics in the biomedical sciences in the last decade, but that this could not be ascribed to a single dominant influence such as Foresight. Indeed, it was considered that the take-up and impact of Foresight had been patchy and that, in the biosciences sector, the main participants may well have been those that already had a strategic view. The pharmaceutical industry, for example, which has always been keen to work with academia, played a major role in the first round of Foresight. UKLSC is advised that the pharmaceutical industry was disappointed that little tangible or innovative resulted from the programme.

4. A large majority of respondents considered that the R&D needs of SMEs in the biosciences sector would be better served by strengthening networks created by regional bioscience development agencies than by encouraging participation in the more distant Foresight programme.

The Impact of the Council for Science and Technology

5. It was agreed unanimously that there is little evidence that the Council for Science and Technology is being effective in providing independent and expert advice to ensure a proper place for science in government policy-making and in co-ordinating the publicly-funded SET effort. The rundown in departmental R&D spending, the withdrawal of funds from MAFF against the advice of departmental civil servants, the BSE crisis, and the handling of the GM crops issue, can be quoted as instances of the Government either not receiving, or failing to act upon, the advice of the Council.

6. There was a similar level of agreement that the science community has little idea of what the Council actually does. Improved communication would be beneficial.

The Impact of the Shifting of Emphasis for Technology Transfer Initiatives

7. It was agreed strongly that there has been a cultural change in the biomedical sciences so that many academics are now much more aware of the potential for exploiting their work. This is probably due to a number of influences in addition to direct government policy. The observation of national and international developments in exploitation of molecular biology by the biotech and pharmaceutical industries, pressure on universities to interact with business and the community, increased acceptance and recognition of exploitation activities by peers, greater institutional support for spin-outs and business development, and the opportunity to augment academic salaries, may all have contributed. However, awareness does not necessarily translate into action, since for many scientists exploitation of discoveries is not a major motivating factor, and so there is a growing need for effective technology transfer management in universities.

8. A majority of respondents considered that financial pressures on universities to obtain matching funds from industry in order to draw down government funds from a range of initiatives had led to better exchange of ideas and information with industry. But it was also thought that many academics who already interacted with industry would have brought their collaboration within the scope of matched funding schemes in order to take advantage of them. Some respondents noted that schemes such as the Joint Research Equipment Initiative are too lengthy and cumbersome. Handing the responsibility for their administration to the Research Councils might simplify procedures.

9. A large majority agreed that undergraduates and postgraduates should be exposed to entrepreneurship, the culture of exploiting discoveries, and industrial research. Many excellent post-docs will not be able to pursue a career in academic research, and their training should enable them to find rewarding alternative outlets for their research expertise.

10. It was agreed unanimously, and often stated strongly, that the Government now needs to focus on encouraging industry to undertake more R&D and to make more effective connections to academic groups, so that it can provide the pull to match university push of technology transfer.

The Impact of Measures to Improve Access of SMEs to Innovation Support Programmes

11. A large majority considered that there are too many bureaucratic support schemes that may confuse SMEs. The plethora of schemes should be simplified, and consolidated programmes made broader, longer-term, and communicated well in advance of their introduction.

12. Within UKLSC's sphere of interest the regional bioscience development agencies are considered to be playing an important and successful role in nurturing SMEs and in helping them to establish academic-industrial networks.

13. A large majority considered that the Government should encourage the transfer of senior scientists between academia and SMEs so that they have experience of both, as the Teaching Company Scheme does at a lower level. Support for this concept was tempered by the adverse effect that secondment of senior academics to the industrial sector could have on departmental teaching and research. If the Government wants transfer to take place from academia then it needs to provide sufficient funding to universities for a full-time and long-time post to cover for the seconded scientist.

The Impact of the Research Councils' More Explicit Commitment to Wealth Creation and the Quality of Life

14. There were divided views on the extent to which Research Council steer had influenced entrepreneurial thinking among academics, with the majority of respondents considering that it was not a major factor.

15. A large majority, but not all respondents, considered that Research Councils are too focused on short-term, goal-orientated research at the expense of basic research, where the major discoveries are likely to be made. In the case of the Biotechnology and Biological Sciences Research Council (BBSRC) the decline in government departmental support of MAFF-funded institutes put pressure on them to resource their applied research from the BBSRC budget, which in turn put more pressure on that Council's basic science budget. The decline in real value of Research Council funding over the period up to the 1997 Comprehensive Spending Review also made it harder to obtain funding for basic research.

16. A large majority considered that there are too many Research Council initiatives that are causing "initiative fatigue" among researchers. A similar majority considered that the primary measure of quality in the SET base should be scientific excellence rather than the potential for commercial exploitation.

17. It was agreed almost unanimously that Research Councils need to work more closely together to guarantee longer-term funding for cross-disciplinary research. One society was pessimistic about prospects for this and commented that there is no incentive among Research Council staff to make it happen, whereas others considered that there are signs of greater collaboration between the Research Councils.

IMPACT OF THE CREATION OF THE POST OF DIRECTOR-GENERAL OF THE RESEARCH COUNCILS (DGRC)

18. A large majority either considered that the DGRC had not played a major role in co-ordinating the activities of the different Research Councils, or felt that they did not know. In either case the conclusion is that the creation of the post was not seen by the scientific community to have had a profound effect.

19. Among those who were aware of the DGRC's activities the majority considered that the present holder of the post focused too heavily on short-term "output-indicators" from the Government's post-1997 investment in the SET base. There was a strong feeling that the DGRC is not sufficiently independent from government.

IMPACT OF THE NEW CAMPAIGN TO SPREAD UNDERSTANDING OF SCIENCE AMONG SCHOOL CHILDREN AND THE PUBLIC

20. The failure of Public Understanding of Science (PUS) initiatives to achieve the desired effect has been discussed extensively, most recently in the report of the Lords Science and Technology Committee inquiry into Science and Society. UKLSC members agreed almost unanimously that such initiatives were worthy, but shown to have been too often wrongly targeted and poorly effective.

21. There was strong support for efforts to be refocused on scientists engaging more with the public on social and ethical implications of their work, as well as on trying to improve the understanding of science particularly among young people. The aim must be to restore some level of appreciation of, and trust in, the scientific community. Science needs to get its message across more effectively to counterbalance the propaganda of opposing lobbying organisations. It is instructive to note that a recent MORI poll commissioned by the Medical Research Council on public attitudes to the use of animals in research found that members of focus groups were readily able to recall negative images of animal experimentation put out by animal rights protesters. But they were unsure where to find impartial information on the reasons why animals are used, and tended to link animal experimentation with secrecy and unaccountability (Times Higher Education Supplement, 26 May 2000).

June 2000

APPENDIX 13

Memorandum submitted by the Centre for Urban and Regional Development Studies, University of Newcastle upon Tyne

INTRODUCTION

1. CURDS is a university-based research centre undertaking research aimed at improving the understanding of urban and regional development processes in advanced economies and employing such research to contribute to the design of more effective policies through an active engagement with policy and user communities[1]. We are pleased to have the opportunity to submit evidence to the Committee, as in the last decade, CURDS has been involved in UK regional innovation policy, as well as assisting the European Commission with innovation and technology policy development.

2. This memorandum seeks to analyse the extent to which the 1993 White Paper *Realising our potential*[2] has been successfully implemented, how science and technology policy has been changed, and whether that framework remains an appropriate form of contemporary governance. We have chosen to focus our reply on one question raised by the Committee in the call for evidence, regarding whether the structures specified by the White Paper are still appropriate. Any evaluation of the efficacy of the elements of the structure must also consider the impacts that those elements have as a coherent system of scientific governance.

REALISING OUR POTENTIAL—A SYSTEM OF SCIENTIFIC GOVERNANCE

3. The purpose of the White Paper was to "give a clearer sense of the vital national contribution made by the ideas, inspiration and dedication of our science and engineering communities, and to devise organisational structures in which the individual can flourish and national priorities and objectives can be more clearly and openly set and pursued" (p. 7). From 1993 to 1997 (the latest year for which figures are

publicly available), national investment in R&D as a percentage of output has declined from 2.1 per cent to 1.8 per cent; Government and Research Council R&D expenditure has also declined from 0.30 per cent of GDP to 0.25 per cent (1993–97). The context to this memorandum is that Government and Research Councils have faced the situation of *managing budget decline*, rather than having discretion and flexibility with which to approach new challenges.

4. The structures established by the White Paper have been affected by major governmental changes. In 1993, the Minister for Science and science responsibility were in the Cabinet Office with Cabinet rank. In 1995, these responsibilities were altered; science policy was moved to the DTI and downgraded to a junior ministerial position. Besides these organisational changes, science and technology policy development was affected by fundamental changes in the policy environment after 1997. Two major innovations in government management of government stress the point that policy-making needs to be holistic to succeed and so delivery requires consideration and co-ordination of complementary policy fields. This was demonstrated in the Cabinet Office *Issues across government* agenda, and the introduction of the Comprehensive Spending Review by the Treasury as a major constraint on Departmental policy autonomy.

5. There is clear evidence that SET policy is closely inter-related to a number of other policy fields. In relation to education, for example, the White Paper and subsequent policies have recognised those linkages[3]. However, linkages are weakest with regard to policies with an explicitly spatial dimension such as planning and regional industrial policy. Yet such linkages are vital because national competitiveness directly derives from the innovation potential of its regions, and a top-down scientific governance system weakens UK economic performance if it cannot direct scientific policy to create capacity for growth and development throughout its constituent regions. This memorandum argues that regardless of the value of particular initiatives established via *Realising our Potential*, the net effect has not made scientific policy-making better at delivering the wider aims and objectives of governmental departments outside a narrow perspective of SET solely for UK competitiveness.

6. The Fifth Committee Report[4] argued this structure had three main effects on Civil Service departmental R&D expenditure. Firstly, the three criteria against which the efficacy of SET expenditure was evaluated were national, promotion of science excellence, technological development and Whitehall support. Secondly, science funding agencies and panels (eg Foresight, Research Councils), viewed SET only in terms of the supporting national competitiveness and hence overlooking its vital role in *creating regional economic capacity* through science and innovation[5]. Thirdly, Whitehall research fragmentation encouraged disproportionate expenditure cuts to meet Treasury spending targets. These three effects characterise a discordant scientific system dominated by commercial interests and driven by the DTI agenda. This is unsurprising given that the White Paper explicated "the central thesis of this White Paper is we could and should improve our performance by making the science and engineering base more aware of and responsive to the needs of industry" (p. 16).

Regional Economic Policy

7. Since the abolition of the unsuccessful Department of Economic Affairs in 1969, no government department has had responsibility for the economic development of individual regions. The Regional Economic Planning Councils were disbanded in 1983; since 1997, responsibilities for the regions has been vested in DETR whilst responsibility for economic development and competitiveness has remained with the DTI; other elements are scattered across Whitehall, with education and training in DfEE, industrial and technology policy with DTI, physical planning with DETR and social well-being with DoH respectively.

8. The purpose of science policy relates to the overall DTI aim "to increase competitiveness and scientific excellence to generate higher levels of sustainable growth and productivity in a modern economy". The 1998 Competitiveness White Paper[6] argues that the key to economic success is entrepreneurship and innovation, and it lists the proposed schemes through which it supports business innovation. In essence the regional dimension of science policy reduces to supporting scientific activities on the basis of merit without regard for their location.

9. This overlooks the potential for the public sector to contribute to the SET base of particular regions. However, the White Paper provides a perfect case study of the linkage between government S&T expenditure and *regional* economic development (see Appendix 1[7]). This is compounded by the fact that the DTI has frequently been criticised by the European Commission for attempting to impose a uniform framework on Commission territorial policies implemented in the UK. There has also been a hidden impact from the privatisation of public research. Privatised corporations have tended to cut back on R&D expenditure, close R&D sites and move from joint product development with UK firms to the acquisition of frequently foreign technology with negative consequences for many UK regions. Similarly, the reduction in public support for industrial research associations has weakened regional research capacities.

10. Responsibility for co-ordination of economic development in the English regions has been vested since April 1999 in the Regional Development Agencies (RDAs), non-departmental public bodies sponsored jointly by DTI, DETR and DfEE. Their main activity to date has been drafting Regional Economic Strategies, for which they were repeatedly informed of the importance of developing clusters, with a mandate not extending much beyond mapping activities and facilitating business clubs. They all faced the difficulty of

trying to write a strategy for a knowledge-based economy knowing that the most critical decisions affecting them are taken without consideration for their regional needs. The most evident case of that since the formal creation of the RDAs was a series of events which this committee has examined comprehensively, the siting of the new Synchrotron facility.

The synchrotron facility—conflicting Departmental interests

11. The case of Daresbury indicates the central weakness of the current framework, **the absence of a transparent mechanism for resolving conflicting priorities between different policy-making groups**. The comments from the Minister for Science[8] concerning the Synchrotron events explicates the DTI's approach to science policy.

12. "The key criterion used in selecting the site for the synchrotron is what is best for the long-term health of UK science. It is clear that both Daresbury and the Rutherford Appleton Laboratory offered viable sites for the location of the new synchrotron. There were, however, four key areas which pointed to RAL as the preferred location: . . . [(iv)] its proximity to the bio-sciences expertise at Oxford University, the MRC units, including the Mouse Genome Centre on the adjacent Harwell site and the National NMR centre" (*ibid*, p.2).

13. The damaging effect of the siting decision on the regional economy of the North West was acknowledged by the DTI in a press release shortly after the RAL decision was taken, announcing £25m of government support to "enhance the science infrastructure in the North West as a consequence of the synchrotron siting decision" (p. 1)[9]. However, its corrosive impact on the scientific capacity of the North West appears not to have been considered in the process. The NWDA strategy notes that Daresbury is the only government research institution of any size in the region, and that NWDA's success in encouraging competitiveness will depend on the degree to which it is able to persuade the Government and HEIs as much as businesses to improve their contribution to what it terms a regional learning economy[10].

14. Considering this case on the merits of the published criteria, it is fair to accept the decision as in the best interests of the UK as a whole. However, it is clear that these criteria have been set in accordance with a DTI philosophy, which unashamedly favours the concentration of the science base in the South East. It is disingenuous to argue market logic underpins these decisions. Heim has unearthed significant evidence from documents released under the 30 year rule that in the immediate post-war period the location of government research establishments was based as much upon the irrational prejudices of particular senior Civil Servants rather than a logical calculus of the scientific potential of particular localities[11]. It only makes sense to view the events as a culmination of several decades of purposive government investment in science and technology, which has served to widen economic, technological and social disparities between core and peripheral areas of the UK. The run-down costs for Daresbury were estimated at £25m-30m, in addition to the £25m provided to the North West Science Review Team to rebuild the North West's public science base. The outcome is directly detracting from NWDA's attempts to improve the performance of its own region, at a total cost of at least £50m to the public purse.

Foresight—dissemination or negotiation

15. The system of governance is limited in its capacity to take regional factors into account in the allocation of infrastructure to promote scientific excellence. Furthermore, the system developed by the White Paper is limited in the degree to which it can formulate scientific priorities in the national interest. The Foresight process is intended to shape UK scientific priorities, but has no mechanism for examining whether different regions should choose to pursue divergent priorities, or indeed even whether different regions should choose to order their priorities differently. In the North East, CURDS' involvement in the "dissemination" of the national Foresight programme indicated at an early stage that to have local relevance, Foresight required regional input [12]. It was clear that firms, especially SMEs, in the regions, found a national priority-setting programme irrelevant; there was thus a need to enrol regional organisations in the Foresight process rather than merely in dissemination.

16. If RDAs are now to develop effective regional innovation strategies these should parallel the national Foresight activities and actively shape the outcomes to give an overall framework with greater relevance for the regions and provide a place for developing more effective partnerships and integration between business and the science base in all UK regions. The only mechanism through which Foresight can currently influence them is to redirect them back towards national priorities in terms of sectors and actions. Significant concerns must be raised as unless national Foresight can incorporate those regional priorities and decisions, DTI's science policy will directly undermine attempts elsewhere in Whitehall to create endogenous scientific potential in all English regions.

The Limits of "Joined-Up Government"

17. A stakeholder analysis of the decision-making process further illuminates this situation. In the material supplied by Lord Sainsbury, it appears that there are four main stakeholders in the Synchrotron decision, CCLRC, The Wellcome Trust, the DTI and the French Government. However, the decision process followed rules the DTI had set. The way CCLRC represented themselves had to follow these rules, without spatial

consideration. When CCLRC are stakeholders in a (DETR) planning inquiry they may choose to represent the interests of their two sites separately, but from the DTI point of view, CCLRC, a national agency was considered as a body with a single opinion (articulated through its director, John Cadogan and later John Taylor).

18. Therein lies the *central weakness* of this system—although a wide range of stakeholders are consulted in the scientific governance process, the way they are allowed to represent their views is directly counter to presenting a perspective that is more appropriate to another policy area or department. Thus, the current system of scientific governance could not incorporate and consider regional development arguments and interest representations; this is symptomatic of an overly hierarchical and rigid policy framework.

19. This is true in other policy fields; there are significant planning implications in the concentration of high-quality scientific employment in the region. For example, the creation of 500 new scientific positions around Didcot increases the demand for high-quality housing and transport in an area under great development stress. Science policy is thus directly undermining the attempts of SERPLAN to contain new economic development to the east of London.

20. Secondly, with respect to cluster policies, its divorce from scientific considerations has two contradictory effects; without integration of clusters into a regional scientific system, cluster policy reduces to an *ex post* mapping exercise and talking shop; by locating in recognised areas of scientific excellence, the cluster policy reinforces the inequalities accumulated over 30 years of spending, favouring the home counties and East Anglia.

21. Thirdly, scientific policy has affected the recent drive to stimulate entrepreneurship. The links between government R&D and new firm formation depend greatly on their relation both with the market and with other key players. This is illustrated in the UK by the differential performance and success of Harwell and Sellafield or Dounreay; Sellafield's activities are more specialised towards a single market, reprocessing and storage, activities whose popularity has markedly decreased in recent years, whilst Harwell benefits from its location in a strong physical science innovation system.

22. It is a worthwhile exercise to gauge the extent to which this funding continues to exacerbate these regional scientific potential disparities. Lord Sainsbury[13] acknowledged that in UK there was a problem with persuading companies to invest in R&D, stressing the importance of government expenditure to support the UK scientific base. Appendix 2[21] presents information from the Central Statistical Office *Research and Experimental Development Statistics 1997*, demonstrating the degree to which government expenditure remains concentrated in those regions immediately adjacent to London. Thus despite a supposed commitment to the support of innovation across the UK, it is clear that the current government framework contains within it the implicit assumption that innovation in the South East is more valuable to national competitiveness than that carried out in Scotland or Wales.

Concluding Remarks

23. The continuing disparities in scientific funding which are an important element of inter-regional disparity in the UK are a direct consequence of the system of scientific governance. Although *Realising Our Potential represented a new era in the relationship between central government and SET users, it did not overcome the problem of co-ordinating science policy between departments. At the heart of this weakness is the Council for Science and Technology, which only looks at Departmental R&D, an activity which has suffered marked cuts in recent years. The government offices would be the natural home for regional science and technology executive officers, which could, through the framework proposed in Reaching Out*[22] report directly to the Cabinet Office Region Co-ordination Unit. Regardless of the actual administrative changes, there are compelling arguments for root and branch reforms of the Civil Service to create loud regional voices in scientific governance, which will undoubtedly require the removal of some scientific responsibility from the DTI.

24. Funding decisions are taken by bodies whose latitude for action is constrained by a need for accountability to Parliament. However, in practice this has meant that the only views that they consider are those that their sponsor department deems appropriate, which often excludes important stakeholders in other policy communities. HEFCE deals with this by having funding formulae which ensure that universities are awarded SET funds on the mixed basis of excellence, capitation and minimum standards, which means in practice that each region has sufficient universities to create a vibrant science base.

25. There has been much rhetoric of the need for government funding to work with the private sector because of the impossibility of national governments funding internationally competitive research facilities. What is however, true, is that it is impossible for science to flourish and explore manifold emergent opportunities under conditions of low and falling science budgets. The European Parliament recently called for R&D in the European Union to be raised to three per cent of GDP; however, if UK R&D was raised to

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[21] Not printed.

[22] Cabinet Office Performance and Innovation Unit (2000) *Reaching out*. London: The Stationery Office

an average of our four main competitors, to 2.52 per cent, then the Government would have to increase spending by £5-6bn in the short run. This would allow the flexibility to both support existing excellence and create new capacities for the benefit of the UK as a whole.

Notes

[8] The Centre has been operating since 1977, with 22 current research staff. Since the opening of the Centre, innovation policy has been a central theme of our investigations, and we have been involved in the ex ante formulation and ex post evaluation of science and technology policies.

[2] Chancellor of the Duchy of Lancaster (1993) *Realising our potential: a strategy for science engineering and technology,* London: HMSO

[3] *inter alia* DTI (1996) *Competitiveness-creating the enterprise centre of Europe,* London: HMSO

[4] Science and Technology Committee (2000) "Government expenditure on research and development the forward look" *Fifth report 1999-2000.* London Stationery Office

[5] Until the curtailment of the cost-plus procurement system in the MoD in the 1990s, MoD contracts had two purposes, to obtain supplies and to obtain a supplier. Government spending on civil R&D has the same effects, but without this necessarily being appreciated by research funders.

[6] DTI (1998) *Our competitive future: building the knowledge-driven economy,* London: HMSO

[7] Not printed.

[8] Science and Technology Committee (2000) "Letter to the Chairman of the Committee from Lord Sainsbury Of Turville, Parliamentary Under-Secretary of State for Science" *Memorandum of evidence 14 April 2000*, London: The Stationery Office.

[9] DTI (2000) "North West Science Review team start work" *DTI Press Release 294 27 April 2000.*

[10] Clause 8 of the 1998 Regional Development Agencies Act; North West Development Agency (1999) *England's North West; a strategy towards 2020, Manchester: NWDA*

[11] Heim, C.E. (1988) "Government Research Establishments, state capacity and distribution of industrial policy in Britain" *Regional Studies 22 (5)* pp 375-386

[12] CURDS & Engineering Design Centre (1996) "North East Technology Foresight networking programme" *Stage 1 Scoping Study report,* Newcastle-upon-Tyne: CURDS/EDC

[13] *The Westminster Hour*, First broadcast 4 June 2000, 10pm Radio 4 (92-95 MHz).

June 2000

APPENDIX 14

Memorandum submitted by the Royal Academy of Engineering

The Royal Academy of Engineering comprises the United Kingdom's most eminent engineers of all disciplines. The Academy's objectives may be summarised as the pursuit, encouragement and maintenance of excellence in the whole field of engineering to promote the advancement of the science, art and practice of engineering for the benefit of the public. The Academy aims to take advantage of the wealth of engineering knowledge and experience that its Fellows possess. The interdisciplinary character of The Academy's membership provides a unique breadth of expertise with which to further all forms of engineering.

By promoting a multi-disciplinary approach, The Academy is able to overcome traditional barriers and to demonstrate the interdependence of different areas of expertise in the efficient use of modern technology and engineering. Emphasis is also placed on the importance of well-informed communication between engineers, Government, research establishments, industry, public services and academia.

The evidence which follows represents a collation of personal views from Fellows of The Royal Academy of Engineering. It cannot reflect the views of all contributing Fellows nor those of The Academy as a whole.

1. General Comments

1.1 A difficulty experienced in attempting to assess the impact of the 1993 White Paper, "Realising Our Potential: A Strategy for Science, Engineering and Technology", is that no objectives were identified and no targets set against which measurements could be made. Nevertheless, the overall response from Fellows when asked about the impact of the 1993 White Paper is that there has been some change but not much is evident, since it takes a long time to achieve a change in culture and style of research and development. The 1993 Paper was viewed as an important and timely document which forced the nation to consider the balance and direction of its research and training initiatives. Fellows have commented that the nation's potential in science, technology and engineering is probably less now that it was in 1993.

1.2 In re-reading the 1993 White Paper the demotion of science and engineering since then is most striking. In 1993, Science was represented at Cabinet level. Now, OST is subsumed into the DTI and led by a junior minister. The wished for co-ordination across government departments has not happened. There is still no clear voice in government for Science and Engineering.

1.3 Despite substantial new funding in the 1997 Comprehensive Spending Review, the UK is way behind many of its competitors in terms of government spend on Science as a proportion of GDP. Government support to the Science and Engineering base from MoD and DTI has declined steadily over the intervening years. The UK is believed to be unique among the technologically advanced nations in reducing the proportion of defence budgets applied to Research and Technology.

1.4 Changes in the status of the Government Research Establishments, from DRA to DERA and now to DERA PPP have done nothing to ensure efficiency and effectiveness of government funded research. Each change has engendered a degree of distrust between the Research Agency and Industry which has taken time to resolve, resulting in delays and inefficiencies in collaborative programmes. One area where some progress has been made is the setting up of DARPs (Defence and Aerospace Research Partnerships) where Academia, Industry and Government Research Agencies can come together to carry out collaborative programmes. But, even here, access to EPSRC funding has been disappointingly slow.

2. The Extent to which the Objectives Set Out in the 1993 White Paper, Realising Our Potential, have been Delivered?

2.1 The annual publication of Forward Look to provide a clear and up-to-date statement of the Government's Strategy for science, engineering and technology (replacing the more limited annual review);

The Forward Look is recognised as having become more focused and concise, targeted at a wider readership. Whilst it analyses expenditure and indicates priorities, it does not give a statement of the Government's strategy—unless the expenditure plans and collection of individual departmental statements are viewed as such. An identified deficiency with the Forward Look is that it tends to focus on obvious application areas whereas it should consider also those areas where science could contribute but where mechanisms are inadequate or non-existent eg social security.

2.2 The creation of Technology Foresight (now Foresight), designed to "achieve a key culture change; better communication, interaction and mutual understanding between the scientific community, industry and government departments";

There are mixed views on the achievements of the first round of Technology Foresight with much variability between the Panels. Initial participants have obtained a better view of the range of different aspects of the technology supply chain and benefited from the network of contacts. Continued efforts are needed to optimise the opportunities for industry/academic interactions. However, the effects of the Foresight programme are second order when compared with the combined effects of global competition and the massive private research, development and product innovation of the leading global companies.

The loss of the Technology focus to Foresight is widely regretted.

2.3 The abolition of the Advisory Council on Science and Technology its replacement with the Council for Science and Technology "to help ensure that the Government benefits from outside independent and expert advice when deciding on its own research spending priorities";

The new Council for Science and Technology appears to be both invisible and ineffective. This is not a good advertisement for openness and accountability in government.

2.4 A shifting of emphasis for technology transfer initiatives to place more importance on "the interchange of ideas, skills, know-how and knowledge between the science and engineering base and industry";

The 1993 White Paper has promoted a culture change within the science community resulting in greater dialogue, partnership and collaboration. A similar culture change within industry would be welcomed. Research Council grant schemes designed to increase collaboration with industry have strengthened and new schemes have been introduced.

2.5 Programmes to improve access for small and medium-sized enterprises to innovation support programmes;

The LINK initiative is viewed as an extremely successful scheme, offering a mechanism for collaboration between the public and private sectors in areas of strategic importance to the national economy as identified by Foresight. The Teaching Company Scheme has also proved to be a valuable initiative in helping industry innovate through collaboration with research and education. A concern which has been expressed is that SMEs often have little spare manpower to investigate each scheme. They have been presented with a confusing picture and hence the objective of engaging them has not been met.

2.6 The reorganisation of the Research Councils with modified structures and new mission statements which made more explicit their commitments to wealth creation and the quality of life.

It is believed that, in general, the reorganisation of the Research Councils has been beneficial in improving focus with more useful industry inputs. The contribution expected of proposed research activity to wealth creation and quality of life has to be stated but this has had the effect of increasing the number of "safe" and "incremental" project proposals. A balance is required between wealth creation, skill development and knowledge creation to ensure that the science and engineering base is not eroded in the long term. Two notes of caution have been raised: one concerns the increasing bureaucracy of research funding which is driving researchers away from academia and into industry; the second is that research strategy is a matter of taste and of trust and that professionals in the particular subject should be involved in the grant-awarding process.

2.7 The creation of the post of the Director-General of the Research Councils and the absorption of the functions of the Advisory Board for the Research Councils into the Office of Science and Technology;

The creation of the post of the Director-General of the Research Councils (DGRC) has increased both collaboration and competition between the Research Councils. The impact of the post can, in part, be measured by the successful outcome of the 1997 Comprehensive Spending Review. The post should be allowed to develop to provide further information before judging the effects of the change. There is a concern that the creation of the post of DGRC has downgraded the positions of Heads of Research Councils with a potential lowering of standards amongst future applicants for these posts as they are now seen as essentially responsible to the DGRC.

A commitment in the 1993 White Paper was to maintain and strengthen the Rothschild customer-contractor principle in relation to departmental applied research and development. Where departments have withdrawn funding from the Science Base the potential results for Research Council Institutes are redundancies, site closures and even loss of a national research capability, with the Science Budget picking up the cost. Another consequence of the privatisation of research establishments is that the staff are no longer civil servants and the flow of scientists between government departments and research establishments has diminished, to the detriment of the departments' development as intelligent customers.

2.8 The launch of a new campaign to spread understanding of science among school children and the public;

The spreading of the understanding of science and engineering amongst the public or schools has been mostly ineffective. The number and quality of young people embarking on science or engineering courses at university level remains a major bottleneck for the UK. Today, fewer school children than ten years ago wish to consider careers in either science or technology. There is a need to rethink how we enter into dialogue with young people—possibly through focusing on teacher training rather than on schools. It is hoped that the Lord Sainsbury initiated review of the role of the Engineering Council will yield positive results.

It has been suggested that to attract people to careers in engineering there needs to be much greater exposure and teaching of "How Things Work". This should be at both Primary and Secondary education level but should be taught not as a scientific, numerate subject, but using language, drawing and visualisation. This would have the additional benefit of creating a more technologically literate society. The academic purity of studying underlying principles before applications is deterring young people from following technological careers. Many of the pioneers of the 18th and 19th century technological developments were practical people, not theoreticians.

3. WHETHER THE OBJECTIVES AND THEMES OF THE 1993 WHITE PAPER REMAIN APPROPRIATE TO THE DEVELOPMENT OF A STRATEGY FOR SCIENCE, ENGINEERING AND TECHNOLOGY AND, IF NOT, WHAT OTHER THEMES AND OBJECTIVES WOULD BE MORE BENEFICIAL?

3.1 The objectives and themes of the 1993 White Paper are generally considered to remain appropriate but with a need for a shift in focus. More must be done in those areas where progress has been slow eg the promotion of science and engineering to the young. The availability of skilled people is becoming a limiting factor more so than in 1993, exacerbated by an even greater shortfall in good schoolteachers, with a longer-term problem foreseen.

3.2 A reservation expressed about the 1993 themes concerns the failure to address the globalisation of industry and research. The previous model was based on UK-industry and UK-academia working together but each is becoming increasingly difficult to define as global alliances are established.

3.3 It has been pointed out that the changes in the 1993 paper were about the funding of R&D or improvement in the use of those funds A S&T strategy should be more than R&D funding eg guidelines on the use of scientific advice have little to do with funding as such but are an integral part of any S&T strategy. S&T does not equal R&D.

4. WHETHER ATTEMPTS TO DELIVER THE PROPOSALS OF THE 1993 WHITE PAPER HAVE RESULTED IN A CULTURE CHANGE ACROSS, OR IN PARTS OF, THE SCIENCE, ENGINEERING AND TECHNOLOGY BASE, AND, IF SO, WHAT IS THE NATURE OF THIS CHANGE AND HOW HAS IT BEEN DEMONSTRATED?

4.1 The extent of any culture change is very varied across the differing sectors of society but attitudes towards the importance of science, engineering and technology within a wealth creating economy remain unchanged. The benefits of the progress of technology are not recognised whilst the media pressurises the public with stories of health scares without quantification of risk, leaving scientists forced into a position of having to prove "negatives".

4.2 Communication with the young and schools has been ineffective. It is recognised to be a highly complex issue but there is a lack of understanding of the challenge and the resultant effects of change.

4.3 The Foresight activities have improved communications in certain areas through the creation of networks. However, the most effective changes to culture have arisen through market forces—expanding markets, global competition. Government policy has to be configured to work with these forces and help produce effective results. Tax incentives would appear to be necessary to encourage change in major areas of UK industry.

5. THE GOVERNMENT'S RECENT CONSULTATION ON SCIENCE AND INNOVATION STRATEGY STATED THAT "THE AIM IS TO USE THE UK'S EXCELLENCE IN SCIENCE TO ACHIEVE IMPROVEMENTS IN OUR NATIONAL INNOVATION PERFORMANCE AND SO TO IMPROVE THE COMPETITIVENESS OF THE ECONOMY AND THE QUALITY OF EVERYONE'S LIFE" AND INDICATED ITS PLANS TO ACHIEVE THIS BY:

- sustaining the excellence of the science and technology base;
- encouraging private investment in innovation;
- streamlining knowledge transfer schemes and focusing them on clear goals;
- fostering regional networks;
- improving the flow of skilled scientists and engineers to industry;
- improving the ability of the science base to play a role in the knowledge economy;
- taking advantage of the globalisation of research; and
- improving public confidence by creating greater transparency in the regulation of science.

DO YOU AGREE THAT THESE ARE APPROPRIATE AIMS FOR A NATIONAL STRATEGY FOR SCIENCE?

5.1 The aims listed, although mainly the means by which a strategy for S&T can better be delivered, are believed to be appropriate but consideration should be given to their prioritisation. The flow of trained people is especially important but this depends on the willingness of industry to employ them on attractive terms. Lack of recognition of the need to offer good rewards in the parochial UK labour market will result in the loss of expertise to the global research market.

5.2 To ensure the supply of trained people in engineering and technology the academic base has to be sustained with people of the right calibre. The strategy must include schools as long term sustainability demands effective teaching of science, engineering and technology if the other stated objectives are to be achieved. The limited funding of universities and the low pay to university scientists will not achieve the aim of sustaining excellence. In the short term it will result in the flow of skilled scientists and engineers to industry but, already, even the major universities are experiencing a decline in the number of applicants of expected standing for academic posts. It is being said that "students are often brighter than the staff", giving rise to serious concern for the education of future engineers.

5.3 The "reducing half-life of knowledge" has been identified as a concern since it requires people to prepare for more frequent "re-skilling". Those at a more mature age with a passion for science, engineering and technology will have to be retained by "re-skilling" when their particular skills set becomes redundant.

5.4 Government initiatives to stimulate entrepreneurial growth, whilst applauded, suffer from difficult and complex regulations. This is thought to betray a begrudging Treasury influence more concerned with closing loopholes rather than a spirit of encouraging innovative companies.

6. WHAT DO YOU BELIEVE SHOULD BE THE MAIN FEATURES OF A MODERN STRATEGY FOR SCIENCE, ENGINEERING AND TECHNOLOGY AND WHY?

6.1 The main features of a modern strategy for science, engineering and technology must encompass the promotion of excellence whilst maintaining and expanding the education and training base. Without a supply of trained people of adequate quality, global companies will relocate elsewhere but, whereas a focus on wealth creation and social welfare is understandable, it must not be at the cost of stifling "blue skies" activities: research driven by the perceived needs of "customers" stifles ground breaking innovation. There must be a strategy to encourage a flow of people trained to think, operate and contribute to a highly complex technical world: the output from government funding of the university system. Professionals practising in the fields of science, engineering and technology must acquire the skills necessary to communicate effectively with the general public through the media. This in turn will help attract able youngsters and encourage a better understanding in society.

12 June 2000

APPENDIX 15

Memorandum submitted by the Biotechnology and Biological Sciences Research Council

INTRODUCTION

1. The BBSRC welcomes this opportunity to contribute to the Committee's inquiry into the impact of the 1993 White Paper, *Realising our Potential.*In the seven years since the publication of the White Paper, there have been significant changes in the organisation of, delivery mechanisms for and outcomes from publicly funded research in the UK. It is therefore timely to consider the extent to which these changes have met the objectives of the White Paper, and to identify where further changes may be helpful.

2. This submission will make general observations on the impact of the White Paper, before addressing each of the issues identified in the letter seeking evidence, focusing in particular on matters of relevance to the BBSRC and its academic and user communities in the biosciences.

THE OVERALL IMPACT OF REALISING OUR POTENTIAL

3. The explicit functions of publicly funded research within the UK have broadened since the publication of *Realising our Potential.* At the time of publication, it was widely recognised that the UK produced high quality research but lacked the skills and structures necessary to exploit the research to its full potential. The general aims of the Paper were therefore to improve the UK's capability to build on its research excellence to the benefit particularly of the UK economy. It is clear that now in many parts of the science base there is a far greater awareness of the commercial opportunities and other social benefits emerging from research. Significant progress has been made in developing knowledge transfer skills within the UK research community, and in the consequent exchange of relevant information and expertise between the science base, industry and other research users.

4. Within the BBSRC structural changes were introduced to pursue the technology/knowledge transfer agenda, and to integrate consideration of the potential for exploitation and public good of the research funded with assessment of its scientific excellence. Some of these are set out in further detail below. Moreover, a new general framework for identifying and pursuing the Council's research priorities was set out in the *BBSRC Strategic Plan, 1999–2004* The framework comprises 10 objectives of which six are science based, but refer explicitly to exploitation, innovation, economic sustainability or specific industrial sectors; of the remaining objectives, one focuses in particular on training, one on knowledge transfer, and one on public understanding.

5. While the BBSRC and other Research Councils have been at the forefront of activities to implement policies in the White Paper, this has not been so apparent in other sections of government with responsibility for the science base. In particular, the other side of the dual support mechanism, under the direction of the Funding Councils, does not emphasise sufficiently the contributions research should be making to the UK economy and to the quality of life. Most significantly, in its current form, the Research Assessment Exercise does little to encourage universities to be proactive in commercialising their research. Furthermore the funding formula used by the Funding Councils has tended to drive up volume, in particular student numbers, at the expense of adequate provision for research infrastructure.

THE EXTENT TO WHICH THE OBJECTIVES SET OUT IN THE 1993 WHITE PAPER HAVE BEEN DELIVERED.

6. *Realising our Potential* stated that "it is the fundamental theme of this White Paper that a closer partnership and better diffusion of ideas between the science and engineering communities, industry, the financial sector and government are needed as part of the crucial effort to improve our national competitiveness and quality of life." An assessment of the impact of the individual objectives must be made within this context although, in some areas, it is too soon to make a considered judgement.

7. At a general level, the BBSRC has worked very effectively to secure the involvement of its research users in the Council's decision-making processes. All its decision-making bodies (Council, Strategy Board, Research Committees and Network Groups) draw at least 40 per cent of their membership from industry and other users (including government departments, consumer groups, farming). The Council has also, with some success, encouraged its scientific community to communicate and, where appropriate, collaborate with users through a number of schemes and incentives. Some of the details of initiatives and their results will be set out below, in discussion of the impact of the specific objectives of the White Paper.

Objective 1: The Forward Look

8. The White Paper indicated that the *Forward Look* would be used to make government efforts on science and technology more explicit and open, and specified a particular audience: industrial and academic research communities. The document provides a clear statement of the Government's commitment to science and technology, and explains the role of the Office of Science and Technology, as encapsulated in its mission statement. It also provides ample information on the flows of funding into institutions and areas of science, and contains a wealth of detail about the scientific priorities of all the Research Councils and relevant government departments. However, the 1999 edition has rather little on how these priorities relate to an overall strategy for science and technology. As this edition was the first to be published for three years, and followed the Comprehensive Spending Review, it was an opportune moment to spell out such a strategy and how the different public funders could contribute to it. Moreover, while the *Forward Look* explains current research priorities, it is not clear that industrialists and researchers have made use of it. The BBSRC has had very little response to its section.

Objective 2: (Technology) Foresight

9. According to the White Paper, expectations from the Foresight exercise were three-fold: to inform government's decisions and communities; to tap into the expertise of people closest to emerging scientific, technological and market developments; and to achieve a cultural change, involving better communication, interaction and mutual understanding between the scientific community, industry and government departments.

10. The Foresight process has been valuable in further encouraging networking and discussion between the science base, industry and government. There is also clear evidence of cultural change in some areas of the science base, but the extent to which this was driven explicitly by the Foresight programme is uncertain. Individual Research Councils already had in place—or were developing—mechanisms for identifying emerging priority research areas, which considered the medium to long term. It is reassuring that the outcomes from those activities mapped closely on to the outcomes of the first Technology Foresight exercise.

11. A more disappointing aspect of the first exercise was the time horizon on which it focused. One of the main reasons why the results matched those of organisations such as the Research Councils was that it looked to existing horizons rather than beyond them. The BBSRC anticipates that the second exercise will be more successful in identifying and addressing longer-term possibilities.

Objective 3: The Council for Science and Technology

12. The BBSRC welcomes the notion of an independent, outside body to advise the Prime Minister and the Government on research spending priorities. However, the specific role of the CST and the impact it has had are not obvious. It should also be noted that the intention was to make the CST's advice readily available. This has not been the case, and the BBSRC would recommend that this aspect of the objective should be fulfilled.

Objective 4: A shifting emphasis for technology transfer schemes

13. This was a central element of the 1993 White Paper, and one in which the BBSRC has invested and continues to invest significant effort. The Council's Business and Innovation Unit (BIU) has a remit to encourage and catalyse exploitation activity, monitor and evaluate performance, and introduce specific measures to enhance knowledge transfer and to promote industrially relevant training. Among its key areas of activity are the promotion of the exchange of ideas between the science base and industry, collaboration with the Department of Trade and Industry (DTI) and other government departments on innovation issues, and developing BBSRC policy for schemes intended to promote academic/industrial research collaboration (eg LINK).

14. Specific initiatives pursued by the BBSRC in order to encourage knowledge transfer include:

- the promotion of knowledge generation in collaboration with industry through, for example, LINK, CASE and Industrial CASE awards;
- the encouragement of industrially relevant training through the Integrated Graduate Development Scheme, and support for modular courses;
- knowledge transfer through "people transfer" using the Teaching Company Scheme and Industry Fellowships;
- improvement in the management and exploitation of IP in the bioscience community through a rolling series of IP workshops and the Biotechnology Exploitation Platform initiative;
- the development of entrepreneurial training at the postgraduate and postdoctoral level through the BBSRC Young Entrepreneur Scheme;
- encouragement of spinout company formation through the Bioscience Business Plan Competition, and provision of bioincubator facilities at several BBSRC institutes, with access to seedcorn funds. The first of these was particularly successful, with 120 research groups registering an interest; 16 were selected to develop detailed business plans, several of which have since attracted further venture capital and seedcorn funding.

15. In addition, the BIU has developed expertise on intellectual property and is able to advise its research community on issues relating to IP in the biosciences. This activity is an essential part of the BBSRC's commitment to optimising the prospects that the research and training it funds are exploited to the economic benefit of the UK.

16. These activities have resulted in a growing awareness within the biosciences research community of the needs of industrial users and a measurable increase in the community's commitment to the exploitation of their results. Particularly within the BBSRC-sponsored institutes, whose activities in knowledge transfer are subject to a rigorous assessment, the attached figures show upward trends since 1995 in industrial consultancies, IP held and exploitation income generated. (See attached charts)[23]. The BBSRC is also developing procedures to encourage key bioscience departments in universities, by seeking exploitation data from them on an annual basis.

Objective 5: Access for SMEs

17. The BBSRC is conscious of the vital role played by SMEs in developing new technologies, particularly in the biosciences. The Council is equally aware of the specific difficulties faced by SMEs in becoming involved in Research Council schemes. As a result the Council invests resources in identifying appropriate SMEs, and encouraging them to take part in BBSRC's decision making procedures and helping them to take advantage of existing opportunities. Now a significant number of SMEs participate in the LINK and Industrial CASE schemes, and a growing number of representatives sit on BBSRC's Research Committees and Network Groups. The Council also encourages the creation of spinout companies through, for example, its Bioscience Business Plan Competition referred to earlier. In addition, the Council has encouraged its institutes to be proactive in commercialising their research and already has in place many of the measures recommended in the Baker Report. There are already a number of examples of spinout companies and three of the institutes have established bioincubators, with associated seedcorn funds, to nurture start-ups. The Babraham and Roslin Institutes are also establishing bioscience parks for more established bioscience companies.

Objective 6: Reorganisation of the Councils

18. The formation of the new Councils with their specific remits to underpin the research needs of their user communities has led to a change in outlook. This is particularly so in the case of the BBSRC, because of the huge growth in the potential to exploit research in the biosciences. The creation of the BBSRC brought together for the first time funding for all UK non-medical life sciences, providing the opportunity to build a national strategy for research underpinning a vitally important and growing industrial sector. The BBSRC has made significant progress in developing this role, as set out in the *Strategic Plan.*

19. Bringing together the previously separate elements of the biosciences from the old AFRC and SERC created new interfaces with the physical, engineering, medical and environmental sciences. The BBSRC has worked consistently to design mechanisms which work effectively at these interfaces. The use of a joint committee (with the EPSRC) for biomolecular sciences has been particularly successful, and recent joint working with the NERC on research into gene flow, and with the MRC on the Tissue Engineering Research Centre are proving effective. There are, however, a number of areas at the interfaces between the BBSRC and the EPSRC where effective co-ordination needs to be further developed.

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[23] Not printed.

Objective 7: Roles of the OST and the DGRC

20. The initial formation of the OST, with the aim of bringing together cross-departmental responsibilities for science and specific responsibilities for the Research Councils and their part of the science base, was welcome in principle. It should have given a single focus for the consideration of publicly funded research and the development of national science policy. However, in practice the aims have not been achieved: the two main remits of the OST are not well integrated, perhaps because it is not feasible for both functions to be fully integrated. The roles of the Chief Scientific Adviser must be to advise the Prime Minister and government on the big issues in science (for example BSE, genetic modification), and to influence the research agenda across all relevant government departments. It is difficult for these functions to be accomplished from within one of those relevant departments. Ideally, the CSA and the CSA's office should have a central and independent location within Whitehall. Furthermore, given the importance of science to an advanced economy, there are grounds for reconsidering the CSA reporting through a Minister for Science of Cabinet rank.

21. The post of Director General the Research Councils (DGRC), with responsibility for the Science Vote and the Research Councils, is not well positioned within the DTI. The continuation of a ring-fenced Science Budget and comparability of influence of all relevant government departments on that Budget, would be more straight forward if the DGRC, and the associated executive, were positioned outwith any of those departments, as was the case when the OST was part of the Office of Public Service and Science. The BBSRC would also take this opportunity to reaffirm its commitment to the Haldane principle of an arm's length relationship between government and the decision-making processes of the Research Councils, whilst acknowledging that some funding needs occasionally to be held centrally at OST to cover major, cross-Council initiatives.

Objective 13: Public understanding of science

22. The campaign to improve the public understanding of science launched by the White Paper was timely and had an obvious and welcome impact. The volume of activity in this domain has been enormous, including: the growth of Science Week, the development of the Edinburgh Science Festival, the British Association's annual meeting, and the growth of lottery-funded science-based facilities (eg Techniquest, the Manchester Museum). Following its successful Consensus Conference on plant biotechnology held in 1994, the BBSRC has organised a number of public discussion meetings, and developed interactive displays, seeking feedback on scientific issues directly from the public. Researchers funded by the Council are now required to devote time to issues of public understanding and awareness and the BBSRC provides media training for scientists to support them in this activity. The BBSRC has also appointed an Expert Group to advise Council on identifying and handling bioscience issues which may be of concern to the general public. In common with the other Research Councils, the BBSRC has developed an extensive and very successful schools programme. The Council has also built important links with the Women's Institute, and has a significant presence at the Royal Show and other high-profile public events.

23. The rapid development of the World Wide Web is also very significant for increasing public awareness and understanding of science. In view of the potential of the web for providing up-to-date, well-researched information, including learning materials for schools, the BBSRC is currently redeveloping its website. The Council plans to use the website for public consultation including, in due course, using this medium for public discussion of its planned research initiatives. The BBSRC is also contributing to the Funding Council led project HERO, the development of a web portal as a showcase for UK universities and research. This is aimed at a variety of audiences including the general public.

Other objectives

24. Although the Committee's call for evidence does not specifically refer to the other principal objectives in *Realising our Potential,* we would make the following comments on them.

Obective 8: Maintaining the dual support system with clearer mechanisms for co-ordination between OST and DfEE

25. The BBSRC strongly endorses the maintenance of the dual support mechanism, but would question the effectiveness of co-ordination between the OST and the DfEE. At the level of the Research Councils and the Funding Councils, while it has been possible for the BBSRC to build effective working relations with the Higher Education Funding Council for Wales, whereby the BBSRC has been consulted, for example, over the allocation of research infrastructure funds within Wales, relations with the Higher Education Funding Council for England have not been as effective.

Objective 9: Maintaining Rothschild customer-contractor principle and pursuing prior options

26. The focus of this objective was on government departments and government research establishments. From the point of view of the BBSRC, the Council would not welcome an extended programme of scrutinies of its sponsored institutes, given the comparatively recent conclusion that there is a clear public need for these institutes. We would also remind the Committee of the difficulties faced by the Research Councils when Government Departments withdraw funding from research institutes at short notice. This was emphasised in the recent Committee report on the *Forward Look,* which criticised MAFF's use of the Rothschild money.

Objective 10: Drawing together cross-Departmental S & T, ensuring value for money

27. Following the White Paper, in common with the other Research Councils, the BBSRC entered into discussions with cognate government departments and agencies about formal liaison arrangements. It currently has Concordats with six (DTI, MAFF, DETR, the Health Departments, SERAD and the Environment Agency), and a Memorandum of Understanding with the Welsh Assembly. In some cases these have led to improved liaison and co-ordination of research programmes, as have some other cross-departmental fora (eg the various research funders' groups). It is always, however, important to guard against these becoming little more than "talking shops".

Objective 11: Improving co-ordination across European and international S & T programmes

28. BBSRC has actively sought to build international linkages where these benefit the UK science base, working with OST, the FCO, British Council and other bodies. BBSRC was proactive in contributing to negotiations on the European Union's Framework Programme 5 (FP5) and alerting the community to the funding opportunities, and will play a similar role in input to FP6. BBSRC has actively developed links with its sister organisations in France, Netherlands, Japan, China, Korea, USA, and Canada. Collaboration between scientists worldwide is encouraged where this meshes with BBSRC priorities. It is important that a more co-ordinated approach is developed, by OST and the FCO, taking input from the Research Councils, to address international SET issues, both to add value to the UK science base and to use SET as a vehicle to promote UK interests overseas.

Objective 12: Postgraduate training

29. In the light of the White Paper, the BBSRC introduced the Research Masters (MRes) course, which has been broadly successful. The BBSRC has funded courses at nine universities for the last five years. About two-thirds of students go on to pursue PhD courses, and the feedback from students has been positive. It is, however, still too soon to assess the impact of the MRes on the quality of PhD students (eg in terms of readiness for the course and submission rates). In addition, in the spirit specifically of the White Paper, several other initiatives in training have been taken, including those listed in paragraph 14.

ARE THE THEMES STILL APPROPRIATE?

30. The majority of the objectives and themes of the 1993 White Paper are clearly still appropriate, particularly the major theme of exploiting the science base to the benefit of the UK economy and for the well being of the population. As set out above, a great deal has been achieved in encouraging and improving the dialogue between researchers and research users. Initiatives in this area must be maintained and enhanced if the momentum is not to be lost.

31. Bioscience industries continue to demand that the UK maintains a world lead in basic bioscience research. The BBSRC continues to strive towards this goal by encouraging high quality research proposals across its remit, whilst particularly seeking proposals in areas of emerging scientific opportunity and to generate knowledge in collaboration with industry.

32. Some of the specific mechanisms suggested in *Realising our Potential* may not have been as effective as anticipated, for example, the use of the *Forward Look* to inform academic and industrial researchers, and the structures envisaged for cross-departmental co-ordination. However, the needs for mechanisms to deliver the objectives of communicating national science priorities to specific groups, and of improving cross-departmental co-ordination are still obvious.

CULTURE CHANGES?

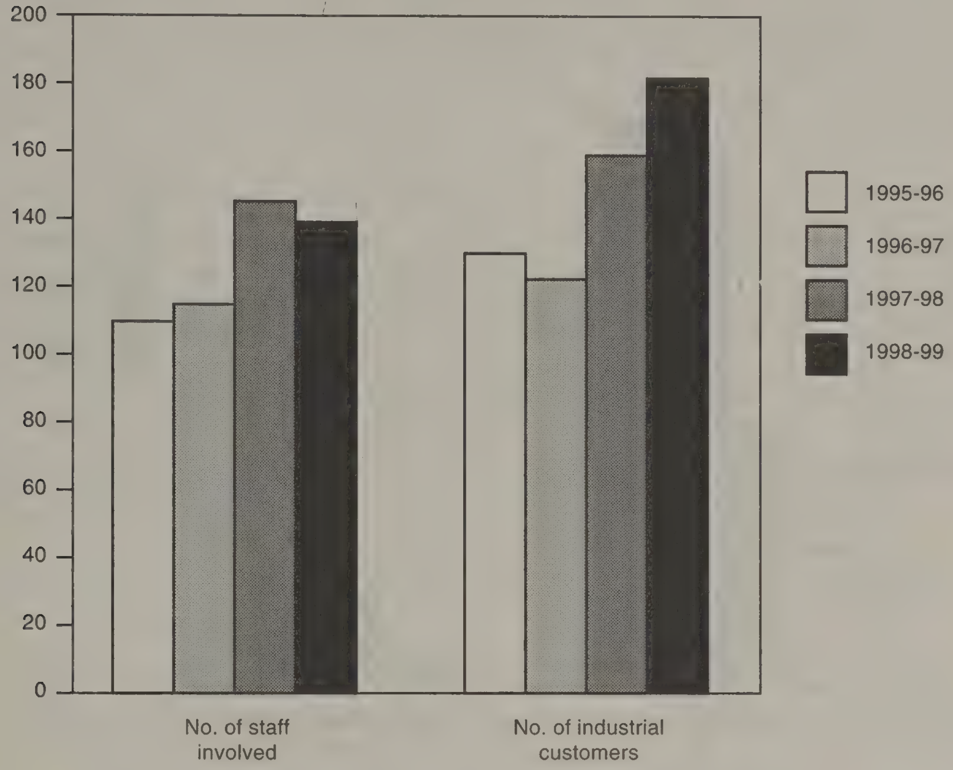
33. Within the BBSRC's research communities, there have been clear changes. The evidence for these is set out above (see paragraphs 14, 16, 17 and 22). BBSRC has been particularly successful in encouraging its sponsored institutes to engage with the knowledge transfer agenda, and is currently working with its principal university departments (ie those which receive the greatest level of funding) to follow a similar route.

AIMS AND FEATURES OF A MODERN STRATEGY FOR SET

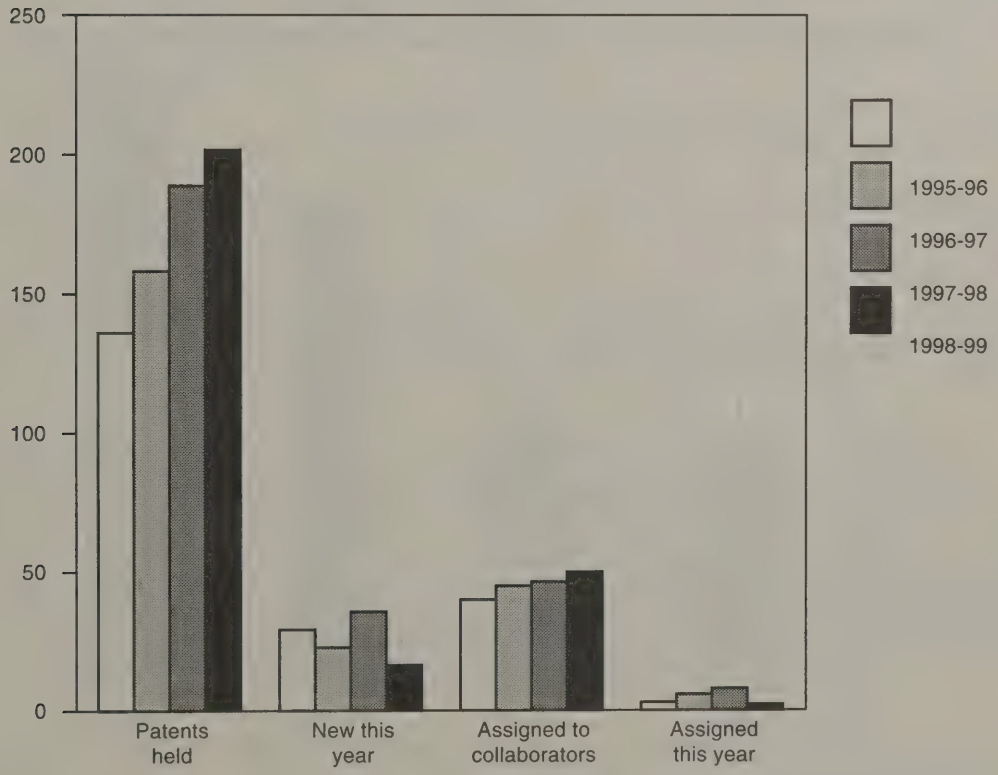
34. The BBSRC's views on the plans set out in the Government's recent consultation exercise were provided in the Council's response. While the BBSRC endorses the broad policy thrust of these plans, it is clear that the ability of the UK science base to drive forward the knowledge based economy and society envisaged depends on meeting a number of key needs. These include:

- providing resources to ensure the UK remains internationally competitive in scientific research. This may involve funding priority areas underpinning economic development and enhancement of quality of life, whilst recognising that the benefits of research cannot be predicted at the outset, and therefore there is a need to sustain a broad base of fundamental research;
- keeping the physical infrastructure for the science base up to the highest international standards in key research centres in universities and research institutes;
- ensuring that government-supported knowledge transfer schemes are effective and that resources are available for early stage development of ideas generated from the research base;
- ensuring that the teaching of science subjects in schools is not undermined by poor facilities or poor quality teaching. Good salaries for secondary school teachers must be available;
- raising PhD stipends to a level that will attract high flyers;
- making research careers more attractive by reducing the incidence of short-term contract employment in the early stages of a career, and increasing the level of early career remuneration;
- ensuring that public debate about science is well informed, and that increased weight is placed on assessing the views of the public before establishing research priorities.

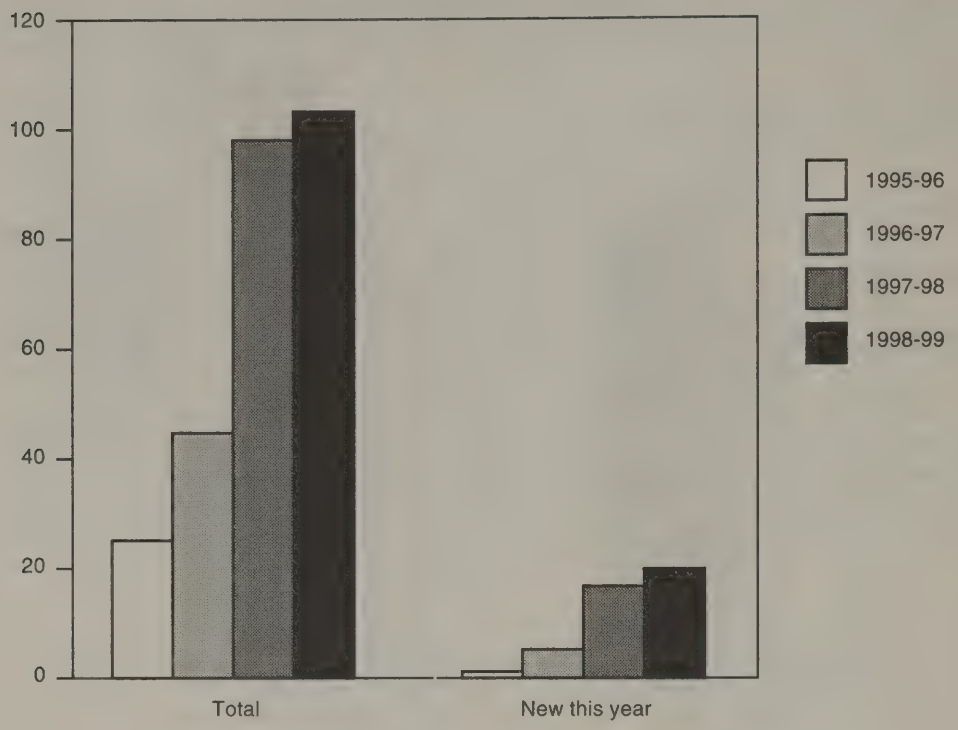
Knowledge transfer indicators: BBSRC-sponsored institutes, 1995-99
Industrial consultancies



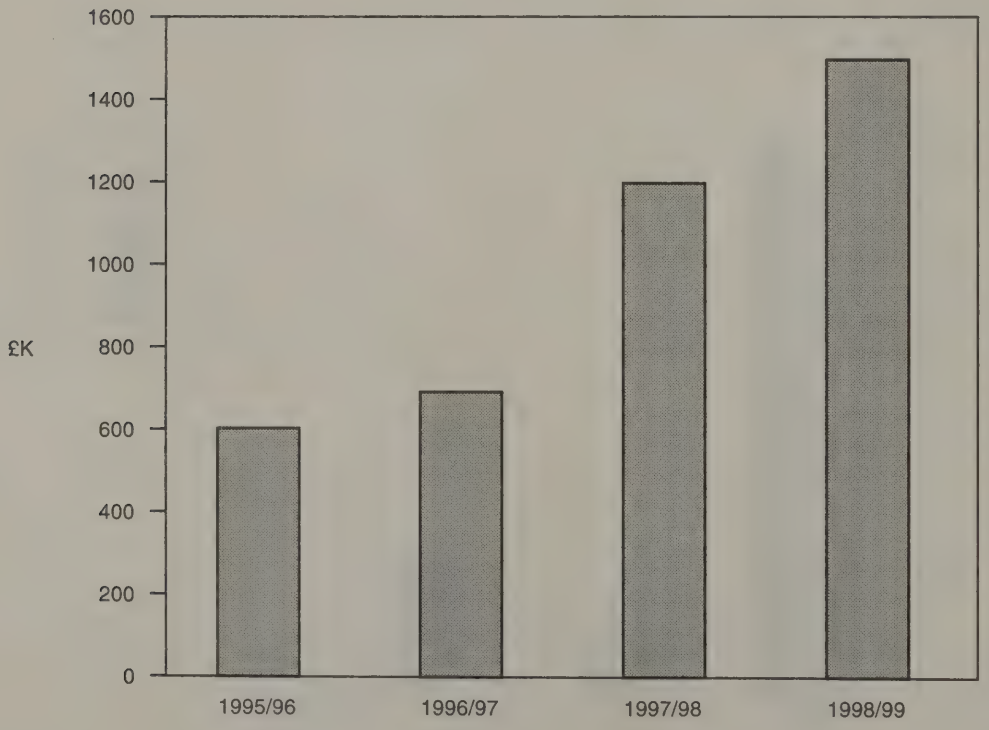
Exploitation indicators: BBSRC-sponsored institutes, 1995-99
Patents



Exploitation indicators: BBSRC-sponsored institutes, 1995-99
Commercial licensing agreements



Exploitation indicators: BBSRC-sponsored institutes, 1995-99
Income from IPR



Response to Questions from the Committee

QQ.I & II—Key Principles

Question I: Do you agree with the Government's aim for the strategy?

We agree with the aim, which is all embracing, but suggest that it is expanded to "..science and technology..".

Question II: Do you agree with the eight proposed areas for action?

We broadly agree with the proposed action, though some of the points require further clarification. For example, it is clearly desirable to improve the flow of appropriately trained scientists and engineers to industry, but this should not be at the expense of university science. Some university sectors are already experiencing problems in retaining trained individuals because they are unable to offer a competitive salary.

We have a slight caveat over "streamlining knowledge transfer schemes" where it is important to recognise that different scientific and industrial sectors have different Knowledge Transfer requirements and thus we should not be pursuing rationalisation (or streamlining) for rationalisation's sake.

Bullet 8 is misleading—it is adequately explained in paragraph 18, but the term "regulation of science" in the bullet does not cover the full aim.

QQ.III & IV—Improving the Excellence of the Science Base

Question III: Do you agree with these priorities?

Put more emphasis on multi-disciplinary research

"Multidisciplinarity" is not only at the boundaries between Research Councils, but is equally important between different disciplines within a single Council.

Barriers to multidisciplinary research take a variety of forms, and all need to be addressed if multidisciplinarity is to flourish:

- University departmental structure, both physical and administrative. Little incentive for researchers from different disciplines to meet and collaborate;
- The RAE, subject-based Panels—with the real, or perceived, problem that they do not favour multidisciplinary work;
- Discipline-orientated publications—leads to difficulty in getting multidisciplinary work published;
- Scientific societies—also discipline-based and may be reluctant to accredit researchers with training in other disciplines;
- Peer review—perceived difficulty of getting multidisciplinary research funded because of "multiple hurdles" or committee/board conservatism;
- Language—difficulty in finding common ground because every discipline has its own terminology.

Whilst the importance of multidisciplinary research is now fully accepted it should also be recognised that it can only be based on world class research in a single discipline. One of the most effective ways to progress multidisciplinary studies is for effective collaborations of scientists in different areas.

Put more emphasis on basic technology, alongside basic science

There needs to be recognition that basic science and basic technology are co-dependent; advances in one will stimulate advances in the other. Both contribute to UK competitiveness.

We would express caution of the view that basic technology might have been under-emphasised in the past. It has long been recognised that advances in basic technology are needed to allow advances in basic science and numerous examples are to be found arising from the UK Science Base. It may well be that much of this technology has been developed outside the UK but that gives rise to different issues. Nevertheless an increased emphasis on such technology giving rise to a higher profile is fully justified.

Get the balance right between core funding and grants for research institutes

The priority given to getting the balance right between core funding and grants in the institutes is very welcome. However, the definition of "core" is important, and in the BBSRC case raises the vital question of the future of the MAFF/FSA research budget. The BBSRC institutes were established on the basis of two sources of "core" funding via the ARC/AFRC and MAFF. MAFF no longer accept any responsibility for "core" funding and have been supported in this stance by Ministers.

In order to stabilise the science base in key areas such as animal disease research, animal genetics and grassland and environmental research, it should be emphasised that MAFF, for example, should provide support to maintain facilities which are required for their future requirements. It is not appropriate for these facilities to be maintained from Research Council funding alone.

What are the issues?

Core funding:

- Enables provision of long-term research. E.g. many "sustainability" issues require funding over many years. The Rothamsted Broadbalk experiments, which have been in continuous cultivation for over 140 years are an invaluable national resource; it is unlikely that these would have been continuously funded by grants;
- Allows provision of infrastructure—cost effective when built around groups of sufficient critical mass to undertake leading edge research. Large scale facilities (eg animal housing) can be planned without requiring individual grant applications;
- Encourages multidisciplinarity. Institutes can and do contain the range of disciplines for their mission;
- Enables major programmes to be planned in a more coherent way under the co-ordinated direction possible in an institute. Responsive-mode does not readily allow for equivalent planning to ensure complete coverage of a programme or balance within it;
- Provides a critical mass of expertise in areas of interest to industry that can lead to long term collaborations.

Responsive-mode or initiative grants:

- Provide additional funding to allow exploration of new avenues (without long-term commitment);
- Allow flexibility—allow relatively fast changes of direction into new topics;
- Provide competitive edge. The continual necessity to be judged by open peer review imposes a discipline upon researchers, and should ensure that the best science is funded.

Overall, it is important that core funding is sufficient to provide the critical mass in key areas of an institute's remit, and grants provide the opportunity for flexibility and testing out potential new avenues of research. A rigorous form of assessment of research funded from the core, plus an effective externally-driven mechanism for acting on this assessment, is essential. Finally, it should be stressed that allocation of the core grant of an Institute must be open to rigorous assessments and some element of competition.

Question IV: What changes would you want to see?

The medium to long-term future of the science base will depend to some degree on a continuing programme for renewing infrastructure in universities and institutes—both teaching and research facilities need to be upgraded regularly and equipment has to be kept up to date. Investment in IT equipment is particularly significant in view of the growing demand for large scale data-handling in the biosciences and elsewhere.

The strength of the science base depends also on providing the best training and a satisfactory career structure to all those who will remain in science. In particular, this requires finding and keeping the major research leaders of the future. Biological and biotechnological training is normally a three year first degree followed by a three year doctorate. A minority of people will have had an additional year. This contrasts with the physical sciences, where, for the ablest future sciences, a 4+3 form of training is becoming the norm. It is increasingly clear that a doctorate in the Life Sciences would benefit enormously from a fourth year of study. This might take a number of different forms ranging from a year spent obtaining an MSc or MRes degree following which some, but not all, would proceed onwards to a PhD. In other cases, and with great advantage, a four year period for PhD might be followed which would include many aspects of training in professional skills and other areas. This training would be planned alongside the research programme throughout the four years.

QQ.V—Encouraging Private Investments in Innovation

The Government's recent initiatives on tax and expenditure policies to create a climate for innovation are to be greatly welcomed. The BBSRC agrees that ownership of intellectual property rights should be vested in those who carry out the research and this accords with the policy adopted by BBSRC for research pursued in its institutes and in universities.

It is also prudent to consider in detail the experience of the USA with its SBIR programme. This scheme requires careful analysis however as, whilst there have been many examples of successful and innovative R&D in small firms pursued under this scheme, there have also been instances where money has not been well spent. It may be that the approach could be modified, with benefit, for the UK so that SBIR funds are not seen as "soft money" but rather they are levered with 50 per cent funding from the SME. This may provide a rather harder edge to R&D investment decisions taken. It could be accommodated within the UK system by a significant revamp of the LINK scheme, shifting the focus to start-up companies and eliminating the need for strict financial viability checks (which are a requirement under current LINK procedures and work against support for start-up companies). However it is essential that the Government maintains its investment in the public sector science base and thus if an SBIR-like scheme is to be introduced it should not be funded through a levy on Research Councils.

The Government's actions in promoting venture capital are to be welcomed, as is the availability of seedcorn funds for start-ups arising from the science base established under the University Challenge initiative. However there remains a gap in funding between the point at which Research Council grant support ends and the stage at which the science has been developed such that its commercial potential is clear. It is only at this stage that a convincing case can be made to launch a start-up company based on seedcorn, venture capital or business angel funding. Often relatively small sums of money are required, £50-100K, to fill this development gap, and so allow reduction to practice. As part of the spending review, the Research Councils have already submitted a bid for resources to provide such development gap funding.

QQ. VI & VII—Facilitating Knowledge Transfer

It is to be welcomed that the document recognises the need for "flexibility to meet the different needs of different kinds of firms and sectors". It needs to be recognised that knowledge transfer covers a broad swathe of activities which may be classified as:

- knowledge development in collaboration with industry;
- knowledge transfer through people transfer;
- development of entrepreneurial skills;
- IP management and exploitation;
- promotion of start-up companies.

It is always likely that a range of schemes will be required to ensure effective promotion of these activities appropriate to the particular area of the science base and the characteristics of the industrial sector(s) it serves.

The BBSRC has had particular success in promoting entrepreneurial skills for postgraduates/postdoctorals through its Young Entrepreneurs Scheme, and the development of well thought through business plans from its bioscience base through its Bioscience Business Plan Competition. The Research Councils, through their intimate knowledge of their science base and user communities, are frequently best placed to deliver knowledge transfer schemes. The BBSRC has made particular efforts over recent years to cultivate networks with the wider bioscience knowledge transfer community in venture capital firms, finance houses, accountancy and law firms etc. We therefore feel well placed to encourage the networking necessary to move ideas from the laboratory to the market place.

QQ. VIII & IX—Promoting Regional Networks

BBSRC acknowledges that the promotion of RDAs as strategic integrators would have undoubted benefits in having available regional innovation funds aimed at capturing the benefits of the science base for business needs at the local and regional level. However there is a danger that if too much authority, and funding, are made available at a regional level it could work against national need with individual regions competing rather than developing complementary niches. For example would all regions seek to develop their own biotechnology clusters and, if so, is this the best way for the UK to develop an industrial strategy. There could be merit in following the German example whereby regions have a certain amount of autonomy but there is also direction applied from the centre. In biotechnology, the German BioRegio Competition provides a good example of catalysing, in a co-ordinated way, activity at the regional level. Thus the centre (in this case BMBF) announced that federal funds would be available to support biotechnology clusters in no more than three regions where the criteria for bidding included evidence of regional scientific, industrial and financial/infrastructural strengths as well as consideration of resources which would be put in at the regional level.

Whilst there is much to commend the establishment of regional innovation funds, there is nevertheless a need to retain oversight, in some form, to ensure best use of resources for the national good.

QQ. X & XI—Improving the Flow of Skilled Scientists and Engineering to Industry

The analysis in paragraphs 12 and 13 smacks of complacency. The key issue in PhD training is quality not numbers. In the biosciences, there is plenty of evidence from employers that the quality of the PhD "product" is not what they expect and that this feeds through to the postdoc period too. Tom McKillop, for example, was widely quoted recently, saying that the lead which the UK had previously held over other countries for research activities due to the supply of highly trained scientists had been eroded and, in practical terms, had disappeared. Other senior people in the field have made similar comments.

To increase the supply of PhD/postdoctoral bioscientists of the right quality would require a solution along the lines of the UKLSC Working Party report; four years of PhD funding for high quality students and an increase in stipend to at least £9K.

The take-up by SMEs of PhD/postdoctoral scientists would be further stimulated if a Bursary scheme were created to support a year's salary for scientists to join an SME following a PhD or postdoc contract.

QQ. XII & XIII—The Role of Universities in the Knowledge Economy

Question XII: Do you agree with the Government's view of the diversity of mission of universities?

It has been recognised by Government and HEFCs that there should be diversity within the University system. The Research Assessment Exercise (RAE), by providing research funds in a highly skewed manner on the basis of research quality, has caused this to happen.

Greater diversification is desirable. To enable this to occur a variety of mainline drivers for funding is required. One such idea is described below. To be effective, the nature of funding needs to be driven by performance, and flagged sufficiently in advance that patterns of behaviour can change. Single-call initiatives to promote innovation are less effective.

Paragraph 15 implies a distinction between universities that are world class centres of research excellence and those that are collaborators with local business and regional actors. The real situation is not as clear-cut as this; the two categories are not mutually exclusive. Many universities deliver on both a local and global level.

Question XIII: Do you consider that government could do more, whether through changes to funding systems, or otherwise, to help universities play a full role as drivers of innovation in the knowledge economy?

Further incentives need to be built into the funding system to encourage universities to play a fuller role as drivers of innovation. The funding of universities by HEFCs is presently largely driven by the Research Assessment Exercise. There needs to be a counter-weight, such as a Knowledge Transfer Assessment Exercise, to encourage universities to invest in their knowledge transfer infrastructure. It will be difficult, although not impossible, to devise criteria through which universities are judged in context, measuring their performance against their particular research strengths and the needs of the local and national industrial sectors which they underpin.

QQ. XIV—Taking Advantage of the Globalisation of Research

It is essential to promote the image of the UK as a modern high-tech economy in order to promote both inward investment and to encourage export trade. The recently introduced International Technology Promoters may have a role here although some priority will need to be established as to the sectors they operate in and their geographical focus. Furthermore there is a perception that Science and Technology departments in embassies abroad have been diminished over recent years, and there could be benefit to the UK in bolstering these groups through deployment of staff with scientific backgrounds adopting a more proactive approach.

International scientific collaboration is important in terms of both adding value to the science base in the UK and in addressing science policy issues (eg. biosafety) which cross national boundaries.

Q. XV—Improving Public Confidence

The mass media are the principal source of most people's perceptions of how government takes advice on scientific matters and of the scientific basis for policy decisions. Public confidence will primarily be generated by press, radio and TV reporting. Open publication (including on websites) of advice, research results and assumptions will help to increase confidence as will the establishment of high level working groups to take evidence and publish their views on particular topics.

For the general public, simple and attractive leaflets on eg GM, food safety, made available at supermarkets, banks and post offices would help to disseminate information about government policies on scientific issues.

June 2000

APPENDIX 16

Memorandum submitted by the Royal Society of Chemistry

1. *Realising Our Potential* has had a significant positive impact in terms of the new policies and initiatives started by the Office of Science and Technology (OST) and the Research Councils. The overall vision was and is correct.

2. However, behind the facade there is a long way to go in government, academia and industry before good intentions are translated into effective actions.

3. In government, despite the action taken to safeguard the Science Base Budget, overall cuts in R & D expenditure suggest scant attention is being paid to future requirements: for example, in some government departments, notably MAFF.

4. In universities, although changes in culture and the content of courses are occurring, they are proceeding too slowly to keep pace with business requirements.

5. In industry, there are too many companies who have still not heard of Foresight, and many more who have taken no part in the processes and opportunities put in place by government.

6. Much more work is required before any major success for the strategy from the 1993 Realising Our Potential White Paper can be claimed.

7. The role of learned and professional societies as intermediaries in the implementation of *Realising Our Potential* needs to be acknowledged and supported by government.

8. The Society remains strongly committed to co-operation with government to achieve the successes that *Realising Our Potential* was designed to bring about.

THE SOCIETY'S INVOLVEMENT WITH REALISING OUR POTENTIAL

The Royal Society of Chemistry warmly welcomed the White Paper *Realising Our Potential* when it was published in 1993.

Since then the Society has been closely involved in many aspects of the activities that followed the White Paper. For example, the Society has:

- Actively served on various Foresight Panels and working groups.
- Organised a large number of workshops to explain the process of Foresight and taken creative new initiatives (eg technology car boot sales) to make it a success.
- Worked closely with OST, DTI and the Research Councils.
- Participated in various educational and training initiatives.
- Been a very active participant in Science Week.
- Been active in providing advice to Parliament and government.
- Worked with various regional and business link groups.
- Carried out surveys of chemical industry reactions and held workshops for company directors.
- Made changes within the Society and increased staff to work on Foresight and related issues.

As a consequence the comments the Society makes are made on the firm basis of first-hand experience and involvement in all areas of *Realising Our Potential.*

1. *The annual publication of Forward Look to provide a clear and up-to-date statement of the Government's strategy for science, engineering and technology (replacing the more limited annual review).*

The Forward Look as shown by the Select Committee's recent inquiry answers many of the questions regarding the impact of *Realising our Potential.*

Government does no appear to have a coherent strategy for science and technology. While exhorting industry to spend more on R&D the Forward Look reveals a declining spend in civil R&D by government departments (eg MAFF).

2. *The creation of Technology Foresight (now Foresight), designed to "achieve a key culture change: better communication, interaction and mutual understanding between the scientific community, industry and government departments".*

Technology Foresight as a process has achieved some of its objectives in promoting culture change and improving communications between academia, government and industry.

Culture change in chemistry has at best been only partial in academia and is being brought about by other drivers than Technology Foresight: for example, by the success of start-up companies, changes in funding available from industry as industry changes and by the increasing pace of research with shifts in emphasis.

According to the Society's own survey of UK chemistry departments, academics believe that Foresight influences the Research Councils and hence tailor their research proposals accordingly. However, they are more influenced by the RAE which encourages academic excellence at the expense of applied research. The Society understands that the next RAE will give due weight to collaborative research with industry. Care needs to be taken to find the right balance since the traditional role of universities of providing freedom of research and academic excellence must be maintained.

If the culture in chemistry departments is to change more significantly it will require structured programmes to change attitudes and procedures. In industrial companies successful cultural change has only been achieved by devoting substantial time and money to the process. Nor can universities be expected to change significantly without adequate resources to manage the process, as well as to encourage the outcomes.

Apart from the larger companies that were already practising Foresight, there is little evidence that industry in general has taken up Foresight or that it has influenced industry spending on R&D. In fact during the period that Foresight has been operating, UK industry R&D spending has declined substantially. A recent Society study on Mergers Acquisitions and Restructuring in the UK Chemicals Industry (which can be found at http://www.rsc.org/pdf/general/m&auk.pdf) clearly shows that the liberal climate for business has a downside that is in danger of undermining the UK's S&T infrastructure and reducing our capacity to innovate and compete globally. This is common to many other sectors and has already had damaging consequences for electronics, engineering and car manufacturing.

The change of name from Technology Foresight to Foresight corresponded with the transfer of OST to DTI (which itself may symbolically reflect a peculiarly UK attitude to and discomfort with science and technology). It also signalled a change in strategy from technology to wider business issues, which, while it might make it easier for non-technical people to participate, has also lost its technology focus. At the same time the Government's Competitiveness White Paper stressed the importance of S&T and the knowledge based economy to the UK's future prosperity. (See "Our Competitive Future: Building the Knowledge Driver Economy" 1998).

It is interesting to note that in a discussion on Foresight with CEOs in the chemicals and materials sector, they did not support this expansion of Foresight to address the wider issues, such as supply chain management and future markets. They considered these to be things that they were capable of handling themselves. They would not share their knowledge (competitive edge) with others and would not value the views of people not involved with their customers and not operating in their sector. Their strong recommendation was that Foresight should concentrate on technology and inform companies on how technology could develop and influence their business. They clearly felt that we should put the technology focus back into Foresight. This attitude might be different in other less technology intensive sectors.

An attempt to get companies to carry out technology audits in the same way as they carry out financial audits has not encouraged industry and the City properly to value their technical expertise (http://www.chemsoc.org/chembytes/ezine/1999/inch_aug99.htm). Perhaps this is one reason that so many mergers fail to produce the expected results—ie valuable technology experience disappears as key staff are made redundant. However, reported studies of mergers by City institutions do not consider technology issues. Promises by the DTI to incorporate plans for technology audits as part of intangible asset initiatives do not appear to have been taken forward.

Whilst industry might not have responded well to Foresight, the Society has been very active in promoting Foresight principles and practice to its 46,000 members in industry and academia. We have developed our own Forward Look for Chemistry, analysed industry trends (see above) and implemented a self-help action plan to improve "our" performance. New Society groups have been established to address new areas on the frontiers with other scientific and engineering disciplines. We have pioneered new types of technology transfer events that have been very successful in bringing together companies (especially SMEs) and academic researchers with real results. Through our websites and the Internet we have set up new networks to link companies and academic groups and provide fast access to expertise and customers world-wide.

With their existing networks and their unique position between industry and academia, Learned Societies and Professional Bodies can do much to effect culture change and to achieve the Government's aims for technology transfer ie the "interchange of ideas, skills, know-how and knowledge between the science and engineering base and industry". Their role as intermediaries needs to be acknowledged and supported by government. Current schemes such as Faraday Partnerships (DTI) and Networks (EPSRC) centre on universities, trade associations and research organisations. Learned Societies are not eligible to act as Faraday centres or Network hubs even though they might represent the most appropriate organisations to deliver. We would recommend that current schemes are changed to allow Learned Societies and other relevant bodies to be even more active.

3. *The abolition of the Advisory Council on Science and Technology and its replacement with the Council for Science and Technology "to help ensure that the Government benefits from outside independent and expert advice when deciding on its own research spending priorities".*

The Royal Society of Chemistry has seen little evidence that the Council for Science and Technology has had any significant impact. A recent report on Technology Matters seems to add little new to discussions over the last decade. However, the report "Science Teachers" is well informed and constructive and makes a number of suggestions we hope will be implemented swiftly.

4. *A shifting of emphasis for technology transfer initiatives to place more importance on "the interchange of ideas, skills, know-how and knowledge between the science and engineering base and industry".*

Current schemes to facilitate technology transfer between academe and industry—such as LINK, TCS, and EPSRC (SERC) CASE awards—were already in operation at the time that the 1993 White Paper was published. LINK and TCS have been expanded but many find that the delays in getting plans approved under both schemes is unacceptable. In practice TCS has a low take up by academic chemists probably because the programme was developed in the context of engineering where specific technical problems are more likely to be identifiable rather than proposals for the funding of more open-ended projects which characterises academic chemistry.

It is encouraging that more money has been made available for TCS. We hope that more chemists will find ways of using the scheme.

5. *Programmes to improve access for small and medium-sized enterprises to innovation support programmes.*

Good efforts have been made to provide innovation support programmes for SMEs. Indeed one problem has been that there are perhaps too may schemes, although this has been recognised and attempts at simplification are being made. Generally speaking schemes still need to be more user friendly and more flexible for smaller companies. Decisions on applications for grants need to be swift and confidentiality must be maintained.

With the continuing changes in company structure, the need for flexible schemes will become more of an issue.

6. *The reorganisation of the Research Councils with modified management structures and new mission statements which made more explicit their commitments to wealth creation and the quality of life.*

7. *The creation of the post of the Director General of the Research Councils and the absorption of the functions of the Advisory Board for the Research Councils into the Office of Science and Technology.*

The Society views the reorganisation of the Research Councils and the evaluation of management structures to have been successful. The Society believes that the Council Chairmen are working together to ensure that science at the interface of disciplines is well supported.

The Society notes that some academics say that previous procedures were better than those currently employed but nevertheless believes that overall Research Councils are working very hard to meet the interests of their several very demanding communities.

The role of the Director General in encouraging change in the Research Councils has been positive overall and continues to provide a strong mechanism for biasing research funds in particular areas. However, such is the commitment of all Research Councils to responsive mode funding that the scope for manoeuvre is small.

8. *The launch of a new campaign to spread understanding of science among school children and the public.*

Many positive developments have been made with regard to the new campaigns to spread understanding of science among school children and the public. However, Science Week, which was initially successful, now seems to have lost momentum—at least in London and with national media. Local or regional activities remain successful.

Much activity has been encouraged by the Research Councils, who have started initiatives often in competition with those run by Learned Societies and Charities.

Much has been learned about how to engage in appropriate dialogue between societies and the public but agreed best practice is difficult to find.

There is now an urgent need for collective action amongst the many groups involved. Government initiatives have done little to help focus objectives or activities.

Although the learning curve has been slow, there are now encouraging signs that many of the various groups engaged on issues relating to science and the public are seeking ways of working together.

WHAT NEXT?

A copy of the submission by the Royal Society of Chemistry to the Science and Innovation Strategy is attached[25].

The Society is pleased that the Government wishes to encourage an entrepreneurial culture in universities and that universities should be involved in solving business problems. On the other hand the Society believes the main role of universities to be training and education and that too many key staff may be diverted from their teaching responsibilities. A more explicit policy is required to avoid the total overload of university staff.

We need to consider carefully the relationship between the UK's national R&D initiatives and those being promoted in Europe as, for example, in the paper Towards a European Research Area which was endorsed recently by EU Ministers at the Lisbon Summit. We already have clear evidence of the effect of foreign ownership on R&D levels in the UK in the chemical industry. We must be clear how we are going to maintain high R&D levels of activity in the UK.

As a country, we must make sure we invest appropriately. For example, progress in biology and information technology depends on the physical sciences and engineering. Today it is nanotechnology that offers the prospects for greater advances in these latter areas. Are we supporting sufficient new initiatives in nanotechnology?

APPENDIX 17

Memorandum submitted by The Wellcome Trust

INTRODUCTION

1. The Wellcome trust was established in 1936 on the death of Sir Henry Wellcome, whose will decreed that the share capital of his pharmaceutical company, the Wellcome Foundation, be vested in trustees to support research of a non-commercial nature. Through the public floatation of the Wellcome Foundation in 1986 and the acquisition of the Foundation by Glaxo in 1995, the Wellcome Trust has become one of the world's largest charities, with a current asset base of approximately £13 billion and an annual spend in excess of £450 million.

2. The Trust's mission statement is to "foster and promote research with the aim of improving human and animal health". The Trust strives to achieve this goal by providing individual researchers of the highest quality across the biomedical sciences with the resources they need to pursue their subject through research grants, infrastructure awards and training opportunities. The Trust primarily funds research in the UK, but has a growing number of international programmes, which aim to strengthen research into major diseases in developing countries. In addition, through its Medicine, Society and History programme, the Trust takes proactive steps towards informing the public debate on the social and ethical issues surrounding biomedical research and its medical application.

3. As a major funder of research in the UK, the Wellcome Trust, welcomes the opportunity to participate in this inquiry. We have responded only to those questions which are relevant to our organisation.

REALISING OUR POTENTIAL

4. The Wellcome Trust responded to Realising Our Potential in 1993. Many of the issues raised by this White Paper are still very relevant today: academic careers, technology transfer, working in partnership and the public understanding of science.

Careers

5. It is interesting to note that academic careers, highlighted in Realising Our Potential as an area where there were major concerns, remain so. This includes career structures, participation of women in science and ensuring adequate provision of people with craft and technical skills. We would be supportive of initiatives building on the findings of recent reports (Dearing, Bett, UK Life Sciences Committee), which again highlighted academic careers as a continuing concern.

Foresight

6. The Wellcome Trust, British Heart Foundation and Medical Research Council worked in partnership to develop foresight methodology. The results of this process were published in 1995 as Foresight in Science: An Experiment in the Field of Cardiovascular Research. The process of analysis, consultation and wide debate provided strong, coherent signals to policy makers on options for new initiatives that were likely to

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[25] Not printed.

strengthen the research field against a number of possible futures. Furthermore, the techniques used provided a useful framework for developing an evidenced-based approach to policy making and priority setting. The main lessons learned through the Foresight process included the importance of:

- Consulting users of research outputs early in the Foresight process as researchers and users have quite different perspectives on the future of research fields;
- Capturing minority (possibly maverick) views as well as developing consensus view points;
- Including consultation on non-scientific and infrastructural priorities;
- Identifying areas that could particularly benefit from direct interaction between users and researchers.

Partnerships

7. A key theme of *Realising Our Potential* was the development of stronger partnerships between the scientific community and the research charities. The Trust has welcomed the opportunity of working in partnership with government and would seek to do so in the future where it believes real value is added to the science base as a result. However, the Trust considers that specific objectives must be established early on in any future initiatives between government and research charities, and channels of clear communication must be identified.

8. Government should consider the management resource implications for major initiatives run through partnerships and ensure they are adequately provided for.

9. An example of a successful public-private partnership is the SNP Consortium. The Wellcome Trust has invested £9 million into this £30 million collaboration with 10 pharmaceutical companies and leading academic centres. The Consortium will build on the data emerging from the Human Genome Project creating a high-quality map of genetic markers. Over the next two years, the Consortium aims to identify 300,000 single nucleotide polymorphisms (SNPs or "snips") in the human genome, variations that could be markers for a susceptibility to diseases such as Alzheimer's, diabetes or cancer. The information gathered by the SNP Consortium will be made publicly available to researchers over the Internet. With the SNP map to hand, researchers hope to be able to devise new medical treatments, and treatments specifically tailored to individuals.

SCIENCE AND INNOVATION STRATEGY

10. The Wellcome Trust supports the high level principles outlined in the Government's recent consultation on Science and Innovation. However, we have a number of areas of concern where we would like to see the strategic objectives broadened. We have explored these areas below and highlighted additional features that we feel could be incorporated into any future strategy for science, engineering and technology in the UK.

Quality of life

11. The Trust believes these principles to be narrowly focused on economic gain and improving the competitiveness of the economy, but failing to explore ways to drive the exploitation of research and technological development to improve health and quality of life. For example, the principles fail to acknowledge that in the UK there is a substantial portfolio of biomedical and health services research, funded by both government and medical research charities. The principles focus instead on research that results in patents, and do not acknowledge the many other outcomes of research.

Careers

12. The recent consultation on the Science and Innovation Strategy highlights the need to improve the flow of scientists to industry. We believe this should be expanded to public life, as there is an increasing need for scientifically literate people at all levels of society.

13. We believe a further objective of the strategy should be the development of attractive career structures for scientists within universities. People are at the heart of developing a robust research base and we have concerns that many aspects of scientific careers are not currently attractive (career and pay structure). Evidence is emerging that many young scientists give up research early in their careers. For example, we have recently published our own reviews of Trust-funded PhD students and a follow-up of previous cohorts. The first study found that more than one third of final year students (on four-year PhD courses) were fairly sure they would not remain in any area of scientific research because of their concerns about the academic career structure and pay. The cohort study shows that 81 per cent of Trust funded PhD cohort took a first postdoctoral position, but only 46 per cent remain in academic research after four to seven years.

Infrastructure and overheads

14. The Science and Innovation Strategy consultation document fails to tackle the overwhelming need for investment in infrastructure. We strongly believe that the science base will be unable to meet the expectations of the Innovation Strategy without a similar strategy for continuing investment in university infrastructure, in the form of a rolling programme, so that "catch-up" initiatives, like the Joint Infrastructure Fund (JIF), become unnecessary. Substantial further funding is needed to ensure the infrastructure of UK Universities enables the UK to be competitive in research. As you will be aware, the £750 million JIF fund has been heavily oversubscribed, having so far received a demand of over £3.5 billion with a further two funding rounds yet to come.

15. In addition to the physical infrastructure there is an increasing need to address the requirement for specialised technical staff essential for the operation of research in today's science laboratories and the Trust would recommend the Committee considers the recommendations made in the Royal Society report "Technical and research support in the modern laboratory" (September 1998.)

16. As a member of the Association of Medical Research Charities we believe that the core funding of infrastructure (capital for buildings) and the many other indirect costs of research (general upkeep or running costs of the basic fabric and support services, including libraries, personnel departments, etc) is primarily the role of the Government through university funding. We will continue to meet the direct costs of research through the many types of grants funded following our normal peer review process. In addition to the salaries of over 4,000 researchers, such grants also fund equipment, building, research consumables, travel costs and many other items. The Trust provides the financial resources to cover the direct costs of research as well as salaries. Additionally, the Trust also permits the researchers it funds to spend up to 30 per cent of their time on teaching and administration. We urge that there be greater transparency on the roles of the different funding parties involved.

Knowledge Transfer

17. We believe the question on the best methods for stimulating increased knowledge transfer is clearly a difficult, yet important one. We suggest that it might be useful for the Government to consider how it could help to stimulate greater collaboration and joint working amongst the individual technology transfer units within universities to enhance commercial exploitation of research. This type of joint working is clearly possible as evidenced by the development of consortia to exploit their intellectual property through the University Challenge Fund (for example, the White Rose Biotechnology Consortium, a joint venture of the Universities of Leeds, York and Sheffield).

18. We would also suggest that it would be helpful if there were a clear strategy or framework which set the variety of funding schemes for technology transfer in context. This would also assist in comparative evaluation and should show where the gaps exist. Currently, there are many different government technology transfer schemes, managed out of a range of different departments and agencies, leading to confusion and duplication.

19. The Wellcome Trust has put forward an innovative proposal to improve the interface between academia and industry at the Trust's Human Genome Campus at Hixton Hall, Cambridge. Planning permission has been refused for this development, but we are currently discussing a way forward for the future of this initiative with South Cambridgeshire District Council.

20. We would like to suggest other innovative ways of exploiting outputs of research that aims to improve quality of life, beyond more traditional technology schemes. For example, the Cochrane Collaboration works to ensure that health care decisions in the GPs surgery, at the hospital bedside and organisational level are based on the best available evidence.

Regional networks

21. We believe that regional issues are for government and agree with the Science and Innovation Strategy that regional networks should be promoted, as long as decisions are based on scientific excellence and that scientific quality is not reduced in the long term.

Improving Public Confidence

22. One objective of the Science and Innovation Strategy aims to improve public confidence by creating greater transparency in the regulation of science. We strongly support improving public confidence in science, however, we question whether government is the best body to undertake this? The events of the past few years (BSE; GM crops; cloning; biotechnology patents) show that when an issue does attract public attention, the public clearly does not believe that it has enough knowledge of, or trust in the government system. Part of the problem may be that the public does not feel that non-technical issues—matters of moral and social values—are taken sufficiently into account compared with the "scientific" issues; part may be a cynicism that, when economic matters are at stake, commercial interest will always win out over other considerations; part may also be that people feel they have no way of influencing the decision-making process. These are all

properly matters of politics, not science and technology, and it is the responsibility of government, in consultation with all stakeholders, to devise and implement new institutions of popular representation if it should come to believe that the existing ones are deficient.

23. The Science and Innovation Strategy is focused very much on internal government transparency, we believe that a much broader view is needed and would like to see the establishment of a strategy for the public understanding of science, bringing together all interested parties, to counteract the increasingly anti-science culture in the UK. This process should not be public led, but involve all interested stakeholders.

24. The Wellcome Trust support Sir Robert May's guidelines for the use of scientific advice in policy making.

June 2000

APPENDIX 18

Memorandum submitted by the British Association for the Advancement of Science

INTRODUCTION

1. The British Association (the BA) has for many years been at the forefront of science communication in the UK. Within the multiplicity of bodies now engaged in the public communication of science the BA is unique. It is the only nation-wide organisation, with a comprehensive multi-disciplinary base and with an open membership that is wholly dedicated to improving public awareness and appreciation of science. Its particular roles are to:

- organise exemplary programmes and activities locally, regionally and nationally, and
- provide a focal point for the community of those who communicate science particularly in non-formal setting.

2. The BA welcomes the opportunity to reflect on the impact of the 1993 White Paper *Realising Our Potential*. Our comments refer, in particular, to the campaign to spread understanding of science among school children and the public that was a key plank of the White Paper.

3. Together with the Royal Society's 1985 Bodmer report on the public understanding of science, the 1993 White Paper has been a landmark document in science communication in the UK. By recognising the importance of improving awareness and appreciation of science and technology, ensuring that the Research Councils had a responsibility to promote it, and allocating resources to support appropriate initiatives, *Realising Our Potential* made a significant and lasting impact that should not be underestimated.

THE INFLUENCE OF REALISING OUR POTENTIAL ON THE BA

4.The BA has been one of the principal beneficiaries of the resulting OST support for this area of work. Already recognised within the 1993 White Paper for activities such as its annual festival of science and Talking Science +, the range of the BA's work has expanded significantly in the subsequent years. In particular it has:

- established the National Science Week
- assumed responsibility for AlphaGalileo, the media resource service for European science, engineering and technology
- encouraged young people to become involved in Foresight-related activities
- been the catalyst for creating SPARKS, the South Kensington millennium festival of arts and sciences

5. Realising Our Potential led directly to the BA proposing the idea of the National Science Week, an initiative that the OST has consistently supported since its inception. Co-ordinated by the BA, the week now involves hundreds of organisations across the UK staging events and activities which last year provided some 8,000 visitor opportunities and attracted over 1.2 million participants. Widespread media interest multiplies the audience many times.

6. AlphaGalileo is an internet press service designed to provide journalists with a "one stop shop" for access to scientific news stories from across Europe. Initiated by PPARC, it was passed to the British Association in 1998 and now has partners in six other European countries.

7. The BA has been active in encouraging young people to become involved in Foresight-related activities. Its Vision for the Future programme has encouraged young people to think how science and technology might be harnessed to create the sort of society they want. An on-line version of the initiative is soon to be launched. Visions events have focused on topics such as transport, food, water and energy supplies.

8. The decision to hold the BA's annual festival for 2000 in London inspired the development of creating SPARKS, the South Kensington millennium festival of the arts and sciences. Although not the millennium exhibition proposed in the White Paper, this month-long festival has a much greater compass, involving the Victoria & Albert, Natural History and Science Museums; Imperial College and the Royal Colleges of Art and Music; the Royal Geographical Society and the Royal Albert Hall.

9. Most recently the BA has taken over CREST awards, which were singled out for government support in the 1993 White Paper. The BA now has schemes to stimulate interest and involvement in science and engineering among young people from 5-18.

The Wider Impact of Realising Our Potential

10. The impact of the 1993 White Paper on science communication has been widespread. One very positive outcome is the enthusiastic support given to initiatives by successive Ministers of science.

11. Recently the OST has initiated survey work to help provide a better understanding of the background, behaviour and attitudes of the public. This is a service to the whole of the science communication community and is most welcome.

12. The greater involvement of Research Councils in this area of work is also welcome. Most Councils have established public understanding grant schemes and these have had a positive effect in stimulating their research grant-holders to engage in public communication activities. Similarly, a number of Councils now ask their grant holders to report on such activities. In our view it is important that the Councils work closely together in this area both to avoid duplication and to avoid confusion among the public and in schools where science tends to be perceived in its entirety rather than in the particular chunks represented by the areas of responsibility of the various Councils.

13. Since the White Paper, many have pinpointed the fact that in the academic world, there is little or no formal recognition for effort and achievement in public understanding of science. Many researchers, who would otherwise be willing to engage in activities with the public find themselves unable to do so because of the pressures of the Research Assessment Exercise and/or the criteria for career progression. This is an issue that needs urgent attention from the appropriate bodies.

Public Understanding of Science: the need for new directions

14. Feedback on the national science week and very many other activities shows positive responses from event organisers and participants alike. Public opinion surveys continue to show positive attitudes to science in the UK. Nonetheless the public discussion on issues like GM foods and crops has not been well-informed, and the quality and quantity of young people being attracted into science courses and careers remains disappointing. The same surveys that show positive attitudes to science also show a diminution of trust in science and scientists, especially those from backgrounds that are not perceived to be independent, eg government and industry. This suggests not that there should be a diminution in the effort put into science communication but that there should be some re-focusing and redirection.

15. The recent report on the inquiry into Science and Society by the House of Lords Select Committee on Science and Technology provides considerable insight in this area and is greatly welcomed by the BA. The concepts of dialogue and transparency are ones that the BA fully endorses. The BA is already committed to making activities, such as its annual festival, more focused on discussion and debate and is planning a new headquarters building at the Science Museum with purpose-built facilities for public discussion. A regular programme of discussions on topical scientific issues has also been established under the banner of the BA magazine, Science and Public Affairs.

16. The BA also supports the need for science at school better to cater for those young people—the vast majority—who will not progress into scientific careers but who will nonetheless be citizens in a society where advances in science and technology will impinge on almost every aspect of life.

A Strategy for Science

17. Science communication and science education are issues that must be addressed if any overall strategy for science is to be effective in today's world. Scientists themselves are key to success in these areas. It is easy to make the case for two-way rather than one-way communication and for a school science curriculum whose primary focus is scientific literacy but they represent major cultural shifts. Scientists are used to communicating by lecturing and writing papers. Engaging in discussion and dialogue requires different skills. It involves listening as well as speaking. Similarly a shift in the focus of the school science curriculum will only be possible if higher education institutions are prepared to accept students whose background is different from those who follow the current paths into universities.

18. Like science itself, the challenges, opportunities and techniques of science communication are international in scope. In many parts of the world the UK is perceived to be a world-leader in this area. The international nature of this endeavour and the UK's leading role in it should be recognised and built upon in any future strategy for science.

CONCLUSION

19. This memorandum has focused on only one aspect of the 1993 White Paper, namely that concerned with awareness and appreciation of science among young people and the public at large. In today's world these aspects, though small in some senses, are nonetheless crucial if science and science-based industry is to continue to have a "licence to operate" in the UK. *Realising Our Potential* was a landmark document in these areas. It has led to many welcome developments. But the speed of advance and change in science and the difficulty we all have to keep up has led to increasing public caution and scepticism. The effort which has been set in motion must continue but some change of focus and direction is called for. The recent House of Lords report on Science and Society provides valuable indicators of possible ways forward.

12 June 2000

APPENDIX 19

Memorandum submitted by the Particle Physics and Astronomy Research Council

INTRODUCTION

1. The Particle Physics and Astronomy Research Council is one of the six Research Councils established or re-established by the 1993 White Paper. We therefore welcome this timely opportunity for the Committee to examine the impact of that White Paper. As a broad generalisation we believe that its impact has been positive.

2. The Particle Physics and Astronomy Research Council was itself the subject of a detailed enquiry by the Select Committee, the report of which was published as the Fourth Report of the 1995–96 Session (HC 249-1). The findings of that inquiry were in general very favourable to PPARC.

THE CREATION OF PPARC

1. PPARC believes that overall the creation of a separate Research Council for astronomy and particle physics has been a success.

2. It has put a clearer focus on the issues involved in supporting these subjects, in particular the need to work in large international collaborations, and to plan strategically on timescales of five to fifteen years.

3. It has thus allowed the Council to develop long range strategic planning, to develop strategic international alliances; and to conduct long term "Foresight" activities such as the Long Term Science Review and Long Term Technology Review (in collaboration with all the other Research Councils)—see below.

4. It has allowed the Council to implement the White Paper priorities through policies and practices closely geared to the needs of its user communities; in education and training; in industrial collaboration; and in public understanding of science.

THE IMPORTANCE OF BASIC FUNDAMENTAL RESEARCH

5. The White Paper acknowledged the importance of basic research, and recognised the essential role of government in funding it. However the 1998 Comprehensive Spending Review led to an outcome in which the only Research Council entirely dedicated to basic research (ie PPARC) was the only Council not to receive a significant increase in funding in real terms. That pattern should now be changed—see below.

TECHNOLOGY TRANSFER AND BASIC SCIENCE

6. The White Paper was based on the implicit assumption that basic research leads to applied research which leads, in turn, to industrial or other applications, the so-called "linear model". The White Paper was published in 1993, which happened to be the year in which the World Wide Web (conceived in CERN) started to take off. We would argue that this is the output with the biggest financial and social impact of the entire science base in the last 10 years. It has also demonstrated the deficiency of the linear model, and illustrates the much more complex interaction that exists between basic research and exploitation. Any future science White Paper should recognise those more complex interactions.

7. There are two returns from investment in basic research. In the long term, fundamental science has shown large capital returns. The discovery of the electron 100 years ago is a classic example. Deep understanding leads to long term economic return such as the current electronic revolution. But to achieve our basic science we need new technology, such as software for the World Wide Web—invented as a tool for physicists. These two types of advances are closely tied. Basic science has been and will be a crucial technology driver for all of science and society. There is also a strong need in our brightest and best young people to attack the deepest problems. This is what attracts them to study and research in physics and has been a British strength from Newton onwards.

8. All PPARC research requires technology stretched to its limits often in collaboration with industry. This requires long range planning. PPARC has led the way in developing its own technology foresight activity, and subsequently an interdisciplinary review of the technological needs of the whole science base (referred to above). (Copies of the summary report "Technology for the Future" are enclosed for the Committee).

9. The report shows the extent of commonality of technological interest across different research sectors, and hence the potential for collaborative technology R&D programmes between Research Councils and with industry. PPARC is developing proposals in this area, in collaboration with other Research Councils. We recommend that Government should recognise the importance of such basic technology R&D by providing additional funding to stimulate this area.

INNOVATION—THE NEED FOR INDUSTRY PULL

10. The 1993 White Paper identified university/industry collaboration as a solution to the UK's relatively poor performance in innovation. The later 1998 White Paper on competitiveness "Building the Knowledge Driven Economy" recognised explicitly the primary role of business and industry in addressing this and put forward a number of measures in support, including the additional funding for the science base announced earlier as part of the Comprehensive Spending Review, and measures to encourage more university/industry collaboration.

11. The "Baker" Report to Treasury and DTI Ministers on the exploitation of Public Sector Research Establishments (PSRE) research ("Creating Knowledge, creating Wealth: Realising the Economic potential of PSREs"), stated explicitly (para 1.12) that "The strength of demand from industry is probably the single biggest determinant of the commercialisation opportunity. An industry dominated by large successful companies, for example pharmaceuticals, has the resources to seek out and exploit PSRE research effectively. Small, fragmented, or low margin industries like sections of the UK engineering sector provide little "industry pull". If the Government wants to address PSRE commercialisation in the round, it will need to consider how to maximise industry pull, as well as "PSRE" push". Although that study applied to PSREs, the same applies at least as strongly to university—industry collaboration.

12. At the same time, the UK R&D scoreboard 1999 (published by DTI) shows that while the physical sciences and engineering-based sectors (ie chemistry, maths etc) of Aerospace and Defence, Automobiles, Electronic and Electrical, Engineering and Machinery, IT Hardware, Software and Telecoms have combined sales some five times greater than the combined sales of the Pharmaceutical and Health sectors; their combined total spend on R&D at around £3.8bn was only just greater than that for Pharmaceuticals and Health at £3.6bn. The average intensity (defined as R&D/Sales per cent) was 3.1 per cent for those physical sciences and engineering sectors compared to fifteen per cent for pharmaceuticals and six per cent for Health; and only in Pharmaceuticals did it exceed the international average. These figures demonstrate not only the relative importance to the economy of the physics and engineering based sectors, but also the comparatively low "pull through" which they exert from their own R&D efforts compared to the pharmaceutical sector alone. Any future White Paper on science and innovation needs to be built on these analyses of the UK economy and pattern of industrial R&D spend.

NATIONAL INVESTMENT IN RESEARCH AND DEVELOPMENT

13. The 1993 White Paper in general addressed only one sector of the national R&D endeavour, namely the Science Budget. It did little to recognise that nationally the UK invests in R&D at a lower level pro rata than most of its competitors. UK gross expenditure on R&D as a percentage of GDP stood at 1.9 per cent in 1997 compared to USA 2.7 per cent, Japan 2.9 per cent, Germany 2.3 per cent, France 2.2 per cent (OECD statistics). One component of this is the relatively low level of industrial investment in R&D (outside the pharmaceutical and fine chemical sector see above). Any future White Paper on science and innovation must address this.

14. The other main component is the low and declining level of R&D investment by government departments other than OST. The Select Committee's own Report on "Government Expenditure on R&D : The Forward Look" (HC 196-I) set out their concerns on this issue, and recommended that "the long term decline in funding Departmental SET must be halted and reversed in the forthcoming Comprehensive Spending Review". We would concur.

FORESIGHT

15. The 1993 White Paper introduced the Foresight (then called Technology Foresight) process. We acknowledge the substantial effort, and achievement since then in terms of consultation and the preparation of (many) panel reports, and in the beneficial networking of individuals from different sectors that this inevitably entailed. We have yet however to see evidence of any overall benefit from the process to UK industry, the national economy or to the size, distribution, or nature of the UK's scientific or technical portfolio. There is no equivalent of the US DARPA visible to us driving visionary plans. Any future White Paper should examine, and act upon the lessons to be learnt here.

ISSUES FOR A FUTURE WHITE PAPER

16. The Committee invited views on issues to be addressed in any future Government White Paper on science and technology. The following are further recommendations in addition to points made above.

17. PPARC believes that the Government should demonstrate its commitment to basic research by giving adequate funding to our areas of fundamental science ie astronomy and particle physics. The scientific community's assessment of the future requirements needed to keep UK research internationally competitive has been published in the booklet "Unveiling the Universe". (The full report is on the PPARC Website). Overall PPARC judges that an additional approximately £30 million per annum is needed to meet these requirements.

18. Amongst these, a key requirement for the UK's future in world astronomy is to participate at a significant level in the next global ground-based projects; the Atacama Large Millimetre Array (ALMA) and the planned 30-50M telescope, known for now as OWL (the Over Whelmingly Large) telescope. The UK will be able to participate in these most effectively if it is a member of the European Southern Observatory (ESO). This would also enable the UK to improve its share of 8 metre telescope time, without which we will be relegated in the world league. But even cutting back on existing commitments eg to current telescopes, will not provide enough funding, and only if the Government provide new resources will the UK safeguard its position in this key area of science.

19. A recent review "International Perceptions of UK Research in Physics and Astronomy" initiated by the OST, and conducted by a panel of eminent overseas physicists has concluded that UK particle physics and astronomy is of internationally very high standing, and that a healthy base of physics as a whole was critical to the national economy. It did however "suffer from a low level of funding", and the Panel said "substantial increases are now required in order to bring UK physics research up to international levels". PPARC draws the Committee's attention to this important report, and recommends that Government should act on its findings.

IT AND THE GRID

20. The World Wide Web is transforming the economy in ways undreamed of even five years ago. And we are on the verge of the next generation Web—the massively more powerful computational Grid. The US is developing this fast. Particle physicists at CERN will need this computing infrastructure to analyse data from the next generation accelerator, the Large Hadron Collider (LHC) that will start to operate in 2005. Other areas of science—from genomics, to climate modelling, to astronomy and remote sensing will need similar resources. Action is being co-ordinated at a European level. UK industry must be involved if it is not to be left behind by its competitors. The UK Government must give both the organisational lead, and the funding required to ensure that the UK plays its full part, and thereby reap the full benefits.

European Collaboration

21. Europe has, collectively, a research enterprise on a scale similar to that of the USA. Yet in many areas the USA is still, or is still regarded, as the leading scientific power. Certainly many more young Europeans go to the States for research experience than vice versa. Professor Sir Martin Rees FRS (in Science and Parliament, Vol 57. No 2) has pointed out that "In the big sciences where international collaboration is absolutely essential, the European scene is increasingly healthy", and cites CERN and the ESA science programme as examples of where European science is now able to compete on a par with the States.

22. A future White Paper needs to address the new ideas being put forward by EU Commissioner Philippe Busquin for making European science more coherent and cost-effective; and for using EU funding to catalyse change.

A national strategy for research infrastructure and major facilities

23. The recent issues surrounding the Government's decision on the new Synchrotron source to be sited at the CLRC Rutherford Appleton Laboratory have highlighted the need for the development of a long-term strategy for major national (and international) research facilities.

Science, particularly physics, education

24. The 1993 White Paper recognised the need to increase the nation's scientific literacy and numeracy. There is a national shortage of good science, particularly physics teachers. The Research Councils including PPARC have made efforts to improve the teaching of their subjects in schools. But these efforts seem not to be matched by action from the DfEE. The Council for Science and Technology has recently received a report on teachers' needs in science. The next science White Paper should address how government will mount an integrated programme including both DfEE and OST to improve school science teaching and the recruitment of science teachers.

June 2000

APPENDIX 20

Memorandum submitted by the Institute of Physics

The Institute of Physics is an international learned society, publisher and professional body for physics. With over 30,000 members it looks after the interests of professional physicists and promotes physics education and understanding to all

I would like to take this opportunity to raise two issues of concern to the Institute which do not relate directly to the questions asked. I would be most grateful if you could bring these concerns to the attention of the Committee.

First, the questions asked concentrate particularly on the activities of the Office of Science and Technology (OST) following the White Paper. However, the White Paper also considered science funded via the Ministry of Defence and the Civil Departments of State. In recent years such funding has fallen significantly while the Science Budget of the OST has received a modest increase. The Institute recommends that the Committee pay particular attention to support of science across government, not just that supported by the OST, in the years after the White Paper.

Second, national understanding of the process of research, development and innovation, and the concept of a global economy, has moved forward since the White Paper. A strong research base needs strong public support, combined with other factors, such as a vibrant higher education sector, liberal free-markets, appropriate regulation and a tax system attractive to inward investment. Scientific innovation is more complex than the linear model, by which local discovery leads through a series of linear steps to local industrial products. Nations will inevitably see local discoveries developed overseas, and conversely must maintain receptivity to foreign innovations and discoveries. A narrow focus on the importance of UK science for UK industry is liable to miss many of the key benefits of globalisation.

Some of the points raised in the Institute's submission (eg innovation and the new synchrotron) relate to previous inquiries of the Select Committee. In particular the Institute submitted written evidence to the inquiry into *Engineering and Physical Sciences Based Innovation* (195-II Appendices to the Minutes of Evidence pp. 320–325. Session 1999–2000).

(1) *The annual publication of Forward Look to provide a clear and up-to-date statement of the Government's Strategy for science, engineering and technology (replacing the more limited annual review);*

The Institute makes limited use of this publication, although it recognises that there will be other organisations in science policy, especially government departments, for whom it is more suited.

(2) The creation of Technology Foresight (now Foresight), designed to "achieve a key culture change: better communication, interaction and mutual understanding between the scientific community, industry and Government Departments";

The first Technology Foresight exercise had a negative impact on physics research. Its use to influence the Research Councils' funding policies was detrimental to basic science, as it steered worthy grant applications away from basic science funding in seeking to align Research Councils' priorities to Foresight. Foresight is more suited to guiding strategic development and applied work.

However, Technology Foresight usefully raised the profile of Technology and established relationships between industry and academe. Although the process involved the wider community via surveys etc, the results of Technology Foresight were essentially only seen in the Research Councils, who were obliged to adopt selection mechanisms that were often inappropriate to basic research.

It is too early to judge the second Foresight initiative, but it is hoped that it will have greater effect on R&D in industry.

(3) *The abolition of the Advisory Council on Science and Technology and its replacement with the Council for Science and Technology "to help ensure that the Government benefits from outside independent and expert advice when deciding on its own research spending priorities";*

The Council for Science and Technology (CST) has not yet achieved the visibility that had been hoped for when it was re-launched. Thus, its benefits have been difficult to judge. The Institute is of the view that the CST has an important role to play in informing and influencing policies on scientific issues, and hopes that in due course it can emulate the impact its predecessor bodies had on the scientific community.

Predecessor bodies such as the Advisory Council on Science and Technology (ACOST) were more influential and active, and regularly published reports on issues ranging from biotechnology to industry-academia links, which had an impact on the Government and on the science community. The CST has regrettably been slower in this area, although its report earlier this year on science teaching is to be commended.

(4) *A shifting of emphasis for technology transfer initiatives to place more importance on "the interchange of ideas, skills, know-how and knowledge between the science and engineering base and industry";*

It is not possible to make any judgements as to whether the changes in universities' and academics' attitudes to industry links are a direct result of the White Paper, or are the outcome of a continuing change in culture. However, the Engineering and Physical Sciences Research Council's (EPSRC) Faraday centres, the Particle Physics and Astronomy Research Council's (PPARC) PIPPS schemes (which encourage collaboration with industry), the ROPA funds, and various other initiatives have had positive effects within the physics community. ROPAs, in particular are awarded by the Research Councils for fundamental research linked to industry, further encouraging the community to be entrepreneurial and innovative.

It is of concern that these schemes place the bulk of responsibility on the Research Councils, and they alone cannot deliver. The schemes need a continuing change in public attitudes to research and development and greater manpower to flourish.

Efforts to bring academic science and industry closer are to be encouraged, but have been less effective in the area of physics because of a decline in industrial research and development in the physics-based industries. For instance, the *UK R&D Scoreboard 1999* shows that last year UK industrial R&D in the pharmaceutical sector increased by 11 per cent and health research by 65 per cent, but research in the following physics based areas decreased significantly:

Electronic and Electrical	—16 per cent
IT Hardware	—21 per cent
Media and Photography	—5 per cent
Telecommunications	—16 per cent

The United Kingdom cannot afford to detach itself from such a broad swathe of technology if it is to have a modern forward moving economy.

(5) *Programmes to improve access for small and medium-sized enterprises to innovation support programmes;*

The House of Commons recently concluded that the UK's relatively poor science record in innovation in engineering and the physical sciences is not the result of a weakness in the science base. The UK is strong in its physics research (a point supported by an International Panel of physicists who recently undertook a review of UK physics [1]) and there are more innovative ideas than are taken up and exploited by industry. Innovative science needs to be supported, and industry, in particular the small and medium-sized enterprises (SME), need to shoulder some of that responsibility and offer relevant training/employment opportunities to science based PhDs.

Programmes such as SMART and Business Links have not had the intended impact. SMART has not been a good match to the requirements of most technological SMEs. Business Links was under-resourced and had inadequate business models, and its structures were difficult to follow. It has been replaced by the Small Business Service (SBS), which appears equally too complex to encourage use by companies.

(6) *The reorganisation of the Research Councils with modified management structures and new mission statements which made more explicit their commitments to wealth creation and the quality of life;*

The research funded by the Research Councils is, rightly, of a long-term nature, and it is extremely difficult to measure the economic impact of research. Importantly, much of the impact of research undertaken in the period since 1993 is still to be realised. It is, therefore, too early to comment on whether the reorganisation of the Research Councils has had any major impact on wealth creation and quality of life.

The Institute supports the need to improve the application of science to wealth creation and quality of life, but questions whether the science and technology strategy by itself can offer a route for wealth creation and quality of life. Following the White Paper, competitiveness and innovation have been superimposed on wealth creation and quality of life. Not all the gains from science and technology can be measured in these materialistic and short-term goals. The invaluable contribution made by science to the understanding of ourselves and the universe needs to be taken into greater consideration.

Research funding should be allocated on the basis of the best science, the best people and the most imaginative proposals. The Institute is firmly of the view that a funding policy based on this premise serves the nation well in terms of wealth creation and quality of life.

An International Review of UK physics, concluded that the quality of research in EPSRC managed programmes is lower than research funded in responsive mode [1]. While programmes to encourage research in specific areas will be required, the judgements on what is funded should be done by responsive mode methods.

The Institute is not in a position to comment on the effect modified management structures within the Research Councils have had on their overall operation. However, in the area of physics the different policies and practices of the Research Councils are confusing and, in EPSRC at least, has left the community feeling distant and uninvolved.

The White Paper proposed a structure with six Research Councils. In the years after the implementation of the White Paper a seventh Research Council, CLRC, was created with a funding basis quite different from the other six Research Councils. The Institute is concerned that the financing mechanism operated by the CLRC is not the most effective use of resources nor match to other Research Council priorities. In addition, the Institute is concerned that the process by which the location of the new synchrotron facility was decided and announced has damaged relations in the community and public perceptions of the decision making process. The Institute trusts that the role and operation of the CLRC will receive the Committee's attention, in this inquiry.

(7) *The creation of the post of the Director General of the Research Councils and the absorption of the functions of the Advisory Board for the Research Councils into the Office of Science and Technology.*

The Institute feels that the Director General of the Research Councils (DGRC) could benefit from a more open advisory system.

The Institute is of the view that the DGRC would be ideally located in the Office of Science & Technology (OST), within the Department of Trade and Industry (DTI). As originally recommended by the White Paper, the Chief Scientific Adviser (CSA) should be wholly located in the Cabinet Office, where the CSA can have greater authority to influence independently scientific issues. The placement of the CSA within the DTI has not been beneficial to science, as it has placed restrictions on the CSA when suggesting science and technology policy across government.

(8) *The launch of a new campaign to spread understanding of science among school children and the public.*

The relationship between science and society requires three communities—scientists, the Government and the wider public—to interact together on a basis of mutual understanding. Recent topics such as genetically modified foods have illustrated that there is still some way to go in this regard.

The White Paper has had a positive effect on public appreciation as it gave formal credibility to the movement and authorised real expenditure from the science budget on activities. It complemented the Royal Society's work in the 1980s, which gave scientific respectability to public understanding. In the last 15 years there has been a sea change in attitude by the science community, especially in promoting physics to the public, which was a major part of the Government's strategy. However, while the Research Councils have each incorporated public understanding into their activities, to date they have failed to agree on a collaborative public understanding strategy. Nor has there been an effective imposition of the need for all those receiving public funds that they make their work publicly accessible. Schools and people need a clear understanding of what science means in terms of their present and future lives. With a shortage of teachers in the physical sciences, this does not bode well for the economic well being for the UK in the long-term. In 1993 there were 568 physics graduates entering teaching, and currently the number stands at around 220.

The White Paper sees public understanding as one of the elements in the better provision of scientists and engineers to meet the country's needs. In section 7.2 it proposes changes in the education and training system to achieve this. However, seven years on, progress towards the anticipated goals has been limited. Neither the numbers continuing their studies in the physical sciences post-16, nor the proportion of girls in the post-16 cohort, have increased significantly. Entries to higher education to study the physical sciences and engineering suffer in quality and quantity. As observed by the International Review of UK physics [1], the British educational systems are excessively financially driven, and science comes off worse.

Poor stipends offered to the physical sciences are deterring graduates from entering research careers, which will be detrimental to the future of British physics. Physics research continues to suffer from a low level of funding, and it is the task of the Government and the Research Councils to support young people in physics research and education and to provide them with the requisite funds.

The White Paper proposed a one-year degree, the MRes, as an intermediate qualification at a level between a first degree and a PhD. This degree was ultimately limited in its scope, as it was reduced from a full-scale project to a pilot. The learned societies including the Institute of Physics did not support such a degree, as it was felt that the existing four year undergraduate degrees, e.g, the MPhys, already served as a solution of bridging the gap between traditional (BSc.) first degrees and PhDs.

(9) *Closing comments*

The Institute supports many of the premises and principles of the White Paper, but believes that it will be many years before we will realise the full effects of the recommendations of the White Paper. It is, therefore, still too early to say whether its resulting policies have had a positive effect on UK plc.

12 June 2000

APPENDIX 21

Memorandum submitted by Marconi plc

(1) THE 1993 WHITE PAPER

There have been substantial and global changes in the business environment during the implementation period of the 1993 White Paper. Perhaps the most important of these changes is the revolution in Information Technology including the impact of the Internet, e-business, and the emergence of a new knowledge-based economy. Consequently it is challenging for industry to identify the specific business-related impact of the White Paper other than through particular initiatives such as the Foresight Programme.

The White Paper triggered welcome changes in the management and organisation of the science base. People in industry who have worked with the managers of the UK science base for many years have seen a significant and beneficial change of process and culture. For example there is greater dialogue, openness, and desire to have a shared vision of the longer-term objectives for industry and the science base. Specific Research Council initiatives such as the User Panel and Technology Opportunities Panel of EPSRC are to be commended. Research Council publications, "Forward Look" and "Landscape" documents are now excellent guides that allow industry to understand and interact with research programmes. Industry welcomes the increasing number of interdisciplinary programmes, and will encourage further inter-Council programmes.

Government expenditure through the Research Councils and Funding Councils on the national base of science, engineering and technology (SET), at an annual level of approximately £2 billion in total, is of course substantial. It must be justified, transparent and well managed. After the publication of the 1993 White Paper there were many concerns in the research community that by emphasising "relevance" as well as "excellence", the funding would be moved into near-term business related activities and justified by financial return-on-investment. Fortunately there is no evidence that this dangerous attitude has prevailed. What business and the UK economy needs, and what the 1993 White Paper has influenced, is a national SET community with world-class competencies and an ability to relate to businesses, the economy and the business environment.

From Marconi plc's viewpoint, the primary measure of performance of the national SET base is the quantity, quality and competencies of graduates and postgraduates from universities; and of course the underpinning competencies of lecturers, researchers and research facilities within universities and the national research base. The national SET base should always be capable of creating the next generation of concepts, rigorous science and innovators. It is above all else, a source of knowledge and a source of expertise.

Marconi plc believes it is desirable to have within the national science base a more informed understanding of the business environment. Scientific and technological excellence is important, but is just one of the many factors leading to business and economic success. To be successful in today's business world, a company must have in-depth knowledge of its markets and must be able to competitively provide high levels of value and service to its customers. However these markets, customers and competitors are increasingly global and are being transformed by the electronic business revolution. The structure, pace and process of business is radically changing. Businesses and business strategies have become more agile. Global business alliances form and reform rapidly. Shareholder expectations and the financial market demand new levels of business performance.

Against this backdrop of business revolution, the technology development process is also changing. Businesses like Marconi employ world-class technologists, but the scope and complexity of new product development requires collaboration with world-class research partners. Marconi expects these partners to contribute technological excellence, but they must also have the ability to network and work in teams, often internationally, and understand the business and commercial factors that influence technology selection. The challenge of integrating technological development with business development is fundamental to company success.

Marconi needs to work with world-class research groups and recruit world-class technologists. Where possible, the groups and individuals should possess team-working skills, business understanding and the other attributes referred to above. Consequently Marconi maintains a good relationship with many university researchers and lecturers to discuss the broader business skills and other desirable attributes. This dialogue is crucial to mutual success, and has greatly improved since the 1993 White Paper. One of the more influential forums for discussion is the Foresight Programme.

In 1994, this programme commenced with the title "Technology Foresight" and consequently many participants from industry were senior engineers, technologists and scientists. These people generally were familiar with the national science base and the Research Councils. Participants were well chosen to analyse technological matters and the interrelationship between industry's technology needs, opportunities and the science base. However, as discussed above, business success requires a global presence, in-depth market knowledge, in-depth competitor knowledge, insight to investor expectations and insight to employee motivations and expectations.

These broader business, economic and social factors form an essential bridge between technological success, business success and wealth creation. In retrospect, it seems that although these broader business issues were addressed, many people in industry saw Foresight as a solely technological exercise. It is possible that the Programme would have gained from greater involvement of those in business with skills in marketing, finance, commercial law and personnel for example. Similarly a greater range of academic and science-base disciplines could have been drawn into the studies. Despite these limitations, the first Foresight Programme was a great success in developing dialogue and a shared vision between industry and academe.

The current Foresight Programme has learned from the first exercise and has a wider range of participants. It is important to stress that from Marconi's viewpoint the Programme must have long-term vision, be global in outlook, and involve a wide community to examine the many drivers of change. Foresight should inform scenario studies and should inform broad areas of policy; it is not about "picking winners".

A key measure of the impact of the 1993 White Paper is associated with communication and dialogue. This includes the communication between people in the national SET base and people in business. It appears that communication between technologists, in their specialist disciplines, has substantially increased; through the Foresight Programme for example. It is less clear whether the much-needed interdisciplinary communication has increased.

(2) NATIONAL STRATEGY

The Science and Technology Committee refer to the Government's recent consultation on Science and Innovation Strategy. The outline of plans is good, but the plans should recognise the following issues:

Innovation and competitiveness result from the flow of knowledge and knowledgeable people between the SET base and industry. Knowledgeable people are the most valuable national asset and business asset. Science and Innovation Strategies must therefore relate to the motivation, culture and reward of individuals. The public perception of science, engineering and technology is poor and the number of entrants to a career in SET is declining. Publicity campaigns, for example some excellent individual projects by the British Association for the Advancement of Science or by the professional institutions, are generally too small and inadequately co-ordinated. There is a vital need for a large-scale SET publicity programme to demonstrate nationally, and ideally internationally, the UK's achievements and exciting prospects for a rewarding career.

The world is rapidly being transformed by the "e-revolution". The SET base needs a strategy to use these new technologies to improve research effectiveness; for example by increasing the efficiency of scientific information processing. The science base must also use these technologies to improve their outreach and partnerships with business. Internet and Grid information systems should be exploited in "virtual networks" for interdisciplinary or inter-institution SET research programmes. These networks should at first be developed locally, as huge, cohesive but distributed "knowledge nodes" equal to, or better than, the largest research institutions in the world. When developed, the powerful national knowledge nodes should be extended internationally.

UK SET strengths and strategies must be benchmarked against the best international sources. However, it is not enough to compare the contents of one laboratory bench with the contents of another, or to compare the publications and citations of individuals or teams. To assess the economic and social value it is necessary to compare technology exploitation routes and processes. This is a challenging task, and requires a wide range of skills.

Where possible, higher and further education courses for science, engineering and technology should include a business context or a review of the many factors that bridge technological innovation and economic or social success. Industry needs skilled scientists and engineers, but to be effective in wealth creation they must have additional competencies.

June 2000

APPENDIX 22

Memorandum submitted by the Institution of Chemical Engineers

INTRODUCTION

The Institution of Chemical Engineers (IChemE) is the leading UK body for the accreditation of chemical engineering degree courses and the qualification of professional chemical engineers. Current membership stands at 25,000 worldwide.

The IChemE has been closely involved with many of the activities which arose from the publication of the 1993 White Paper. We have been particularly engaged in both Foresight programmes, running an Associate programme in the current round, and continue to work closely with OST, DTI and the Research Councils. The comments in this memorandum are based on close association with the subject matter.

1. *Are we "Realising Our Potential"?*

The extent to which the objectives have been delivered:

The primary engine of change in the White Paper was the Foresight process. This has had some successes in bringing industry, government and academe together to identify opportunity and methodology. In the process sector, it engaged some of the SMEs and two of the first round funded projects, CPACT and iAc, continue to be successful.

The concept of industry led research funding as a mechanism for achieving "the interchange of ideas, skills, know-how and knowledge between the science and engineering base and industry" followed the IMI model. The main difference was the size of the programmes and the freedom to target areas of technology rather than fairly narrow topics. The main problem with the Foresight funding was that the £40 million of the first round was reduced to a much smaller amount in the subsequent round.

Although this mechanism for achieving the objectives could have been used to disburse much more funding, most money still went through the traditional Research Council route. This lack of commitment to the process means that in academe much of the science base and some of the engineering base need only pay lip service to the Foresight priorities to maintain their funding.

The industrial enthusiasm and funding for Foresight was based on a feeling that industry could have a real impact on the research agenda and create academic centres of excellence in areas vital to the economy. The lack of follow-through in the Foresight funding process will endanger this.

Another mechanism for change was the modification of the Research Council structures and the various committees. This has had less impact than would have been hoped and there is little evidence of a common approach across the Research Councils. We particularly note the impact on bio-chemical engineering across the interface between the EPSRC and the BBSRC.

Another area that is still a problem is the funding of interdisciplinary research. Before the rearrangement, in the process sector, about 50 per cent of "engineering" funds were used to support the underlying science base, mainly chemistry, whilst virtually no "science" funds went to engineering.

It was hoped that the move to more explicit commitments to wealth creation, would force the science base to fund more interdisciplinary research, but this does not appear to have happened. This is not just conservatism or purist behaviour by "science" referees. There is a strongly held belief that the RAE will not value interdisciplinary research and that it does not lead to advancement in an academic science career. There is also a feeling that with too little funding available from Research Councils, the science base would suffer if these were further "diluted". There is clearly a need for a strong science base, some of which is focused on "knowledge" creation, but the balance is still not correct.

The key themes in the White Paper were "wealth creation and the quality of life". The various changes were designed to promote and enforce these themes. This has had some success in the academic community but there are still many in the science base who regard wealth creation as an infringement on academic freedom.

2. *Are the 1993 Objectives still appropriate?*

Although the potential impact of globalisation was evident at the time of the White Paper the pace of change, which has been particularly acute in the industries served by our members, might not have been apparent. Industrially funded research in our industries is now a truly global activity and unless research is world class it will not receive support. At the same time we see other countries, the USA, Japan and Germany for example, making huge investment in specific areas of leading edge research.

Whilst the main objectives of the original White Paper are still appropriate, the pace of change which is so far evident does not provide any confidence that the science, engineering, and technology base in the UK can meet these global challenges. The key question is can the pluralistic approach to research funding promote the growth in centres of excellence in leading edge technologies required to compete in a globally competitive environment?

3. *Culture Change?*

There has undoubtedly been some change in culture since the White Paper was published. Engineering research, which is by nature often interdisciplinary, has become more respectable in academic circles. There has also been a small but significant increase in the willingness of the science base to collaborate with engineering on particular projects. Industry and particularly SMEs have participated a little more, particularly in consortium activities.

In spite of this, there is still a fundamental difference in the mindset and approach of the average engineer and the average scientist that makes the process very difficult. Most engineers want to make things and create wealth and most scientists want to discover things and create knowledge. That is why they chose their disciplines. This makes the setting of joint targets very difficult; engineers see scientists as narrow and unworldly whilst scientists see engineers as unfocused and money-driven. These attitudes have been largely uninfluenced by the White Paper.

The recent discussions on Citation Indices and their appropriateness for engineering research, demonstrates the wide gap in aspirations.

4. *Science and Innovation Strategy*

We agree that the contents of the list cover appropriate aims. However our concern is whether the UK can achieve the pace of change required to maintain competitivity.

5. *A Modern Strategy*

A modern strategy for science and technology should be based wholly on a Foresight process. This will inevitably mean making some hard choices, which may be politically difficult. There has always been reluctance in public life to be seen to be "backing winners". The Foresight process offers a mechanism for engaging all the relevant parts of society in the task.

There is a dichotomy in government funding of academic research. On the one hand, there is a tendency continuously to seek novel mechanisms and schemes to create a sense of movement and purpose. On the other hand, there is a natural inertia, from dealing with such diverse communities, which leads to a lack of zero based funding decisions. This leads both to projects continuing to receive funding, when they are in areas that are no longer strategic priorities and to a lack of continuity of funding for new projects in areas that are strategically important.

Some mechanisms, such as Faraday Partnerships, do have a longer time horizon, but for many mechanisms the funding ends after three years. A modern strategy would seek to identify strategic goals in areas vital to the nation and develop an appropriate funding mechanism to meet those goals.

A nation the size of the UK cannot be a world leader in every area, but there will be areas of national excellence to be maintained and built on. There will also be fundamental technologies that any nation would need to keep abreast of to survive in an increasingly complex world.

The Foresight process offers a national basis for decision-making. The process is not limited to academic research. It could identify educational needs in the population. It could then provide a basis for allocation of funds to educational establishments at all levels.

June 2000

APPENDIX 23

Memorandum submitted by Mr Brian Arthur, Director, Public Affairs, The Institution of Electrical Engineers (IEE)

The Institution of Electrical Engineers has a membership of almost 140,000 professional engineers representing a wide range of engineering disciplines including power engineering, electronics, communications, computing, software engineering and manufacturing. The Institution has responsibility for the accreditation of first degree engineering courses and for ensuring that membership of the profession is only granted to those with the appropriate qualifications and experience. The IEE considers that engineering is an essential element of our society, necessary for national wealth and well being. It also believes it is well placed through its membership, which includes academics and engineers working in industry, and companies (through the IEE Industrial Affiliates Scheme) to comment on the outcomes from "Are We Realising Our Potential"?

The IEE makes the following comments in answer to the questions that you raised in your letter.

1. Many of the objectives of the 1993 White Paper have been met. The annual "Forward Look", for example, is an improvement on the previous annual review of the Government's strategy for science, engineering and technology.

2. The creation of Foresight is a major achievement but the IEE has concerns that the excellent work carried out by industrial representatives, with only very limited Departmental support services, has not yet fully satisfied its main objectives in fostering improved understanding between academe, industry and Government Departments. This is particularly the case for small companies.

Foresight needs to be more proactive in disseminating its results and actively seek a broader range of inputs to its panels. It needs to be seen as more inclusive in its process. Furthermore there is some evidence that all companies are finding it difficult to maintain their level of involvement in the current round of Foresight activities.

3. The Council for Science and Technology has improved the range of expert advice available for determining research-spending priorities. Given the long lead times involved in funded research programmes it is too early to judge the full impact of these changes.

4. The changes to technology transfer programmes to place more emphasis on the exchange of ideas, skills and knowledge, do not appear to have succeeded, particularly again for SMEs. It is suggested that policy should identify and focus on the smaller number of SMEs involved in technology products and markets. Current policy spreads scarce resources too thinly. Small companies face increasingly difficult trading conditions with a high bank rate (compared with other European countries), the strength of the pound affecting raw material costs and the competitiveness of UK manufacturing sector exports, the continued burden of bureaucracy and Government regulation. In such circumstances looking to the longer term becomes a second order priority for companies when their very being is threatened.

5. The reorganisation of the Research Councils has focused more attention on wealth creation and quality of the life issues. There are some encouraging signs but, as with all long-lead-time research, it is difficult at this early stage to find quantifiable evidence of improvement, for example, in wealth creation opportunities for UK industry.

6. A properly constructed and funded evaluation programme is required to compare the situation before and after the 1993 White Paper. Given the continuous nature of change in science, engineering and technology, without such a programme it is not possible to quantify any changes attributed to the 1993 White Paper. In assessing the impact of the White Paper it is not wise to rely on anecdotal evidence or assertions, which are notoriously unreliable in these policy and strategy areas.

7. The proposals contained in the recent consultation on Science and Innovation Strategy are appropriate as a statement of top-level objectives. The problem comes in the interpretation and delivery of these objectives in government programmes and actions. Current government departmental programmes contain a myriad of sub-critical programmes which are under-resourced and sometimes overlapping. The lack of focus creates confusion, unnecessary bureaucracy and wasted effort for companies.

8. The one key area missing from current strategy is focus at the implementation level. As stated above, current programmes do not concentrate on a few major issues, tackle them quickly and effectively—and then move on to tackle other priorities. The majority of government programmes in Engineering and Technology are under-funded and under-resourced. Many do not recognise the real life business issues and problems of SME's, which employ the majority of people in the UK. In particular, funding of the large gap to translate university research to the point at which banks or venture capital will support business plans for a new product. Perversely, the same programmes offer no help at all to middle-sized and larger organisations to encourage them to grow to become global players that will make a major contribution to UK GDP. The Government is seen as not appearing to value the UK manufacturing industry sector as a contributor to wealth creation or to seem truly concerned about its future.

9. The key features of a modern strategy should be relevance and wealth creation underpinned by excellence in education and training, an appropriate scale of assistance from government (when needed)—and a light regulatory touch.

The IEE will be pleased to provide further information on request.

13 June 2000

APPENDIX 24

Memorandum submitted by The Royal Society of Edinburgh

INTRODUCTION

1. The Royal Society of Edinburgh (RSE) is pleased to respond to the Select Committee's request for comments on the "Are We Realising Our Potential" Inquiry. The RSE is Scotland's National Academy of Science and Letters, comprising Fellows elected on the basis of their distinction, from the full range of academic disciplines, and from industry, commerce and the professions. This response distils the views of a wide cross section of Fellows. The timetable for submission meant it was not possible for it to be fully

considered by the Council of the Society, and has, therefore, been approved by the Officers on its behalf. Given his prior involvement as Chief Scientific Adviser in the White Paper, and because he has given evidence separately to the Select Committee, the Society's President, Sir William Stewart, has not been involved in producing or approving the RSE's response.

2. The *Realising our Potential* White Paper of 1993 was an important landmark in recognising the importance of the research base and its contribution to the wealth of the UK. It paved the way for what has been built on and adopted since, and demonstrably raised the profile of science. The development of the Office of Science and Technology (OST) and the reorganisation of the Research Councils have been highly beneficial, resulting in an important voice for science in government. The concepts of public/private partnerships in science funding are now better developed, although the UK is still playing below an international level in industry research and development (R&D). On the whole, therefore, the White Paper must be regarded as a significant success. It would be foreshortening our options and vision, however, to say that we are yet fully "realising our potential": there is ample scope to continue to build upon the White Paper's aspirations.

3. The specific areas of consideration are addressed below:

THE EXTENT TO WHICH THE OBJECTIVES SET OUT IN THE 1993 WHITE PAPER, REALISING OUR POTENTIAL, HAVE BEEN DELIVERED;

4. Many of the issues highlighted in the inquiry have been moved forward significantly as a result of the implementation of many of the recommendations of the White Paper. Overall, progress has been made in most of the areas identified.

The creation of Technology Foresight

5. Technology Foresight caught the imagination of the science and technology (S&T) community and brought together industrialists and academics who were entrusted by the prospects of creating a technology and market blueprint that aimed to enhance wealth creation and improve the quality of life within the UK. Many of the participants in the programme felt that this initiative was overdue. It brought the UK in line with technological powerhouses such as the USA and Japan who have their own technology look-ahead methodologies, and placed us ahead of others. The Foresight process was sometimes misrepresented as a forecast activity that attempts to predict the future. Hopefully this misunderstanding has now been corrected and that it is now recognised that Foresight is concerned with alerting the business and academic communities to market and technology opportunities already on the horizon.

Foresight has provided a useful framework for exploring key issues regarding science/industry links and the processes have produced useful and interesting material. Networking has been greatly enhanced and the outcomes of Foresight have been incorporated into government policy documents. Applicants to the Research and Funding Councils need to know the relevance of their work to Foresight priorities. Attitudinal changes take a long time to develop and we believe that significant change has not yet occurred. What is clear is that the outcomes of Foresight can provide the glue that holds together the goals of *Realising our Potential* and other current or future related initiatives.

It will be difficult in the long-term to de-convolute the relationship between economic success, lifestyle improvements and the Foresight process. However, this should not prevent attempts being made to do this. Possible metrics include trends in: the industrial relevance of science base R&D; the technological balance of payments for the UK; health and other quality of life statistics; patenting activity; number of high-technology start-ups; business expenditure on R&D.

The abolition of the Advisory Council on Science and Technology and its replacement with the Council for Science and Technology (CST)

6. The CST has, from the outside, been relatively low profile. This is not to say that it has not had a positive effect but that it is very difficult to evaluate externally. One view is that it should be more transparent in its advice and commentary. However, it would need to guard against becoming simply reactive, media-driven, or less incisive, in its advice.

A shifting of emphasis for technology transfer initiatives between the science and engineering base and industry

7. The greatest impact of the White Paper has been to promote a change in culture within the science community, encouraging greater dialogue, partnership and collaboration. Most attention has been focused on the transfer of technology and knowledge out of universities, with less being done on the transfer into companies and innovation within companies. The response of industry has been patchy: for example, small to medium-size enterprises (SMEs) have not sought to take as much advantage of links with academia as might be hoped. Universities are, therefore, becoming better at supplying technology and innovation, but there is not the required demand from the UK business base in taking this up, partly because some of what

university R & D is offering does not match UK industry's view of what is exploitable technology. The consequence is likely to be a stronger university base transferring knowledge to export markets where there is both the demand and also the capability.

Programmes to improve access for small and medium-sized enterprises to innovation support programmes

8. It has inevitably been more difficult to deal with the issues of access for small and medium-size enterprises to innovation support programmes. There is a continuing problem with SMEs which no one has solved satisfactorily. There is the constant problem of the resources available within small companies, which are almost always fully stretched. Engaging creatively with additional initiatives, therefore, poses real problems for them. The LINK initiative and Teaching Company Scheme (TCS), however, have been successful.

The reorganisation of the research councils

9. The White Paper has provided the impetus to analyse operations and improve efficiency within the Research Councils, allowing a greater proportion of the science budget to be freed to fund science. Much has been achieved since 1993 through rationalisation, restructuring and finding more efficient ways of working, often through joint initiatives.

10. One of the White Paper's reforms, however, was a commitment to maintain and strengthen the Rothschild customer-contractor principle in relation to departmental applied research and development. The House of Commons Science and Technology Select Committee's Fifth Report: *Government Expenditure on Research and Development, The Forward Look* (March 2000) drew attention to the issue of departments withdrawing funding from the science base, often at short notice. This has often resulted in staff redundancies, site closures and, at worst, loss of national research capability in particular areas. Financially the science budget may, as a result, have to pick up the pieces.

The creation of the post of the Director General of the Research Councils (DGRC)

11. The creation of the DGRC and the absorption of the functions of the Advisory Board for the Research Councils in to the OST has provided a focus for the co-ordination of the activities of the Research Councils, as well as enabling the undertaking of pan-Council initiatives and providing a cohesive platform for the bid for the science vote. One could argue that the latter has been the single most important impact, if measured by the successful outcome of the 1997 Comprehensive Spending Review.

The launch of a new campaign to spread understanding of science among school children and the public.

12. *Realising our Potential* raised the issue of the need for greater efforts to improve public understanding of science and technology and today the Research Councils and a number of bodies, including the Royal Society of Edinburgh, are now involved in a wide range of activities aimed at promoting dialogue between science and society. The recent House of Lords Select Committee on Science and Technology Third Report: *Science and Society,* however, has identified shortcomings in the current relationship between scientists and the public which still remain. The Society's views on this issue can be found in its submission to the House of Lords Select Committee on Science and Technology's inquiry into Science and Society.

WHETHER THE OBJECTIVES AND THEMES OF THE 1993 WHITE PAPER REMAIN APPROPRIATE TO THE DEVELOPMENT OF A STRATEGY FOR SCIENCE, ENGINEERING AND TECHNOLOGY AND, IF NOT, WHAT OTHER THEMES AND OBJECTIVES WOULD BE MORE BENEFICIAL

13. The emphasis of the 1993 White Paper on creating partnerships to benefit UK wealth creation and quality of life is as relevant now as it was in 1993. However, while recognising that the kind of change that the White Paper aimed to bring about takes time, there are specific problems which require further work. For example, as noted above, the industrial input into R&D, and therefore the means of connecting up the high quality of research in universities with the needs of industry and commerce, has still some way to go. The reasons for this are many. In the larger companies it is often the needs of institutional investors who want an annual return as high as possible and company managers responding to the desire for good financial results by constraining R & D investment. In the smaller companies the continuing problems of time and energy and internal resource equally pose barriers, as does the "communication gap" between science and general managers. Some progress is being made, but there is not enough industrial "pull" to maximise the advantages of the UK's research base.

14. A significant development since *Realising our Potential* is devolution. As was concluded in the Royal Society of London and Royal Society of Edinburgh's joint study into *Devolution and Science,* the science, engineering and technology base should remain well integrated on a UK level with as few internal barriers as possible. The Research Councils, which are a reserved UK function and which should remain so, and the devolved Higher Education Funding Councils, should recognise their important roles in maintaining the UK

SET base. At the same time, devolved powers should be a basis for more effective application of the SET base through the creation of regional alliances, as advocated in the 1998 White Paper on *Building the Knowledge Driven Economy*. The means whereby these latter objectives are attained will vary from region to region, depending upon the nature of devolved responsibilities. It is important, however, that, as the constitutional arrangements become more complex, effective means of co-ordination of the UK SET base are developed.

15. In terms of other themes, there would be merit in more express recognition of such developments as the growing importance of biotechnology, the increasing globalisation of industry and research, and the importance of the value in the international market of knowledge, and of services flowing from the ownership of knowledge.

16. Another area where further attention would be beneficial concerns the research infrastructure within universities. The Joint Infrastructure Fund (JIF) initiative has been good and timely; however, it is essential that as part of the current comprehensive spending review some longer term measures are put in place to ensure that the research infrastructure available in British universities is adequate to the needs of the economy. This adequacy needs to relate to the speed at which technology moves and to allow maximum exploitation of that infrastructure within institutions and through partnerships with other related institutions.

17. With regard to the managing, development and renewal of central facilities, there would also be merit in a systematic approach to new capital facilities. There have, up to now, been difficulties in approving, and now in setting up, the management for facilities, such as the new synchrotron radiation source. As a result, it could be argued that the UK has suffered loss of expertise in managing capital projects and failed properly to exploit the facilities we have.

WHETHER ATTEMPTS TO DELIVER THE PROPOSALS OF THE 1993 WHITE PAPER HAVE RESULTED IN A CULTURE CHANGE ACROSS, OR IN PARTS OF, THE SCIENCE, ENGINEERING AND TECHNOLOGY BASE, AND, IF SO, WHAT IS THE NATURE OF THIS CHANGE AND HOW HAS IT BEEN DEMONSTRATED

18. The emphasis of the White Paper was on the themes of wealth creation, partnership and training. Many of the issues have been taken forward, and are more embedded in the policy making environment and SET community, as seen in the accepted prominence of the role of the science base in future economic development.

19. Within the science community, the White Paper has resulted in the promotion of a change in culture, encouraging greater dialogue, partnership and collaboration, although effort still needs to be concentrated on stimulating industry to innovate and to work with the universities.

THE GOVERNMENT'S RECENT CONSULTATION ON SCIENCE AND INNOVATION STRATEGY STATED THAT "THE AIM IS TO USE THE UK'S EXCELLENCE IN SCIENCE TO ACHIEVE IMPROVEMENTS IN OUR NATIONAL INNOVATION PERFORMANCE AND SO TO IMPROVE THE COMPETITIVENESS OF THE ECONOMY AND THE QUALITY OF EVERYONE'S LIFE". DO YOU AGREE THAT THESE ARE APPROPRIATE AIMS FOR A NATIONAL STRATEGY FOR SCIENCE?

20. The RSE believes the list of aims is appropriate although there could be some mention of science for the public good.

WHAT DO YOU BELIEVE SHOULD BE THE MAIN FEATURES OF A MODERN STRATEGY FOR SCIENCE, ENGINEERING AND TECHNOLOGY AND WHY?

21. The main features of a modern strategy for science should be:

- promotion of excellence in the science base, because only excellence will suffice in a highly competitive global economy;
- fostering of collaboration with industry, because the science and technology base is such a potentially valuable resource to industry and to society generally;
- retaining a global perspective, because of the increasingly global nature of the economy; and
- being open with the public, because only through the provision of better communication of information can the public's unease about science and technology be addressed.

22. While there has been some co-ordination of government department research, co-ordination and integration of departmental research with the main policy making functions should also be a main feature of the science strategy.

ADDITIONAL INFORMATION

23. It should be noted that the Scottish Executive is also developing a science strategy for Scotland. Devolution has changed the patterns of responsibility for regional components of the SET base and is likely to produce regional priorities for it. This will create both risks to the effectiveness of the SET base and opportunities to increase its effectiveness. It will be important to avoid the former and exploit the latter.

24. In responding to this inquiry the RSE would like to draw attention to the following Royal Society of Edinburgh responses which are of relevance to this subject: *The Scientific Advisory System* (June 1998); *Devolution and Science* (April 1999); *Science and Society* (June 1999) and *Government's Expenditure on Research and Development: Forward Look 1999* (December 1999). Copies of this response and the above publications are available from the Research Officer, Dr Marc Rands (email: mrands@rse.org.uk).

12 June 2000

APPENDIX 25

Memorandum submitted by the Environment Agency

INTRODUCTION

The Environment Agency is responsible for environmental regulation and management in England and Wales. It has a duty to carry out research in support of all of its functions. The effectiveness of that research, and of its scientific activities in environmental management, is dependent in part on the ability of the Agency to work with, and draw upon, the environmental research and scientific knowledge of other research players. These comprise other government departments, academia, the research councils, and industry.

Overall, the Agency considers that the 1993 White Paper—*Realising Our Potential*—has had a strong impact on science and technology, and to a lesser degree on engineering policy, in the environmental sector. Our submission highlights the principal impacts from the Agency's viewpoint, and explains how we consider further changes could be achieved which would improve the level of co-operation, and hence promote wealth creation and quality of life.

A PERCEPTIBLE SHIFT

1. We believe there is now a far greater willingness among academia and the Research Councils to co-operate with the Agency in its scientific activities. Looking back at the position prior to the White Paper (with the Agency's predecessor bodies), co-operation was weaker, partly because it lacked the now-accepted common drivers of wealth creation and quality of life. Previously it was more difficult to establish the linkage between work in the science (engineering and technology-SET) base and the more applied scientific and research activities carried out by the Agency.

2. We believe this was only the start of a continuous process—the co-operation now is better than it was, but further changes could be made that would secure greater benefit to the UK.

CONCORDATS

3. Possibly the most important measure for us has been the use of concordats. The Agency has established these with the four main Research Councils with which it works (NERC, EPSRC, ESRC and BBSRC). These documents set out procedures for developing common interests, but their main benefit is the signal they send to staff: active co-operation.

TYPES OF COLLABORATION ON R&D

4. Under these concordats, we have developed a range of mechanisms for co-operation. In particular, with EPSRC, we have co-operated in developing and supporting (with inputs in kind from our staff as well as with funding) its managed programmes; and we have co-operated similarly with NERC on their thematic programmes. It is clear that, as time has progressed, the type of co-operation has matured. The Agency has now supported a number of successful projects in the "SET" base with NERC and EPSRC, where well-defined delivery requirements were agreed, and outputs have been taken up through a further Agency (or user) funded contract. This model for interfacing academic research with delivery of products to the end user is simple in theory, but has been difficult to achieve in practice.

5. Two other mechanisms for co-operation are being developed and improved:

- Fellowships and studentships—we have run many of these in co-operation with EPSRC, ESRC and NERC and have found the research student to be an effective focus for the joint involvement in exploring a particular scientific area.
- Placements and secondments—more recently, as the Agency has developed its national centres as a focus for its scientific expertise in specific areas, we have found these locations to provide an effective focus for placing (not necessarily full-time) research officers and for seconding its own staff into other SET organisations.

We recognise that these types of co-operation are not groundbreaking—this is why we believe that the principal factor that has changed is the will to see co-operation deliver real benefits.

Bridging the Gap between Science and its Application

6. We believe that a number of constraints remain to achieving effective team working between organisations in the SET base and public sector organisations like the Agency that use the research. These are:

- Criteria for "scientific excellence" Where the strong emphasis on scientific publications in the refereed literature as a criteria for scientific excellence detracts at times from the ability of academic and research organisations to form effective partnerships. In particular, the requirements can make it difficult for new applicants for Research Council funds even though the researchers involved have an excellent understanding of the issues and application;
- Difficulties in financing "development" Where there are often difficulties in putting together the finance necessary to fund a significant "development" project. The academic sources of funding (typically a Research Council grant) can stop significantly further away from application than the end-user is prepared to finance. There are also real practical difficulties in bringing together several funding streams, usually on different timescales. The result is that the cleverer academics will often prefer to go for the funding which is more readily available. Nevertheless some areas of SET are now very "mature", in that the principal research issues are focused on the application of the existing knowledge and not the acquisition of new knowledge; and
- Disparate nature of the SET base In many sectors of environmental SET there are too many different groups for effective co-operation. Some sectors would be better served if the nation had fewer, larger groups.

7. While a range of approaches have been made to improve the mechanisms for development (or exploitation of research) and technology transfer, we believe that bridging this gap is the area in which further effort must be made—possibly by OST and the research councils recognising that in some cases more public money should be directed here, rather than into more basic research. There is a need for a culture change, in that users, researchers, and others involved in the R&D chain need to work together in addressing the weakest links in the chain. All suffer from the poor performance of R&D if it does not contribute effectively to improved business performance or quality of life.

Foresight

8. We believe that the Foresight exercise has been generally effective in establishing a broadly owned vision of future issues and opportunities for the application of SET. It has been particularly effective in establishing the concept of "Futures" or "Scenarios" for helping the players in any sector to consider more clearly the future context of SET.

9. We also believe that the "Knowledge Pool" has yet to reach its potential. In general, both practitioners and researchers in the UK spend insufficient time in recording and considering the current application of SET knowledge. More resources could be put into ensuring that the knowledge pool links well into information on "good" or "best" practice in the different sectors that it covers.

Recognising the Policy Lead

10. While there is general understanding within the SET base of how the drivers of innovation work, there is insufficiently close adherence to these in practice in setting the research agendas for the managed programmes within the research councils. "Wealth creation" and "Quality of life" have to some extent become institutionalised. Those in the policy lead may therefore need to take a more active role in establishing the issues to be included in research programmes in the SET Base. Similar issues to this have been raised with the future EU R&D programme.

Career Prospects in the SET Base

11. We believe that the forthcoming White Paper should address the issue of job security and career progression for young scientists in the public sector. The shortage of permanent posts and the need for many young academics to progress through temporary contracts brings far too great a degree of uncertainty into career progression. Not surprisingly, many of the best scientists leave the research arena for other more secure and better-paid jobs.

Integration into the European SET base

12. We believe that the forthcoming White Paper should draw clear links with the EU SET Base and with the EU Framework Programmes in particular. The latter form a significant impact on environmental R&D, therefore relevant areas of the UK science policy should be integrated with EU policy and mechanisms.

FUTURE PLANNING

13. Because of the many ways in which a large business like the Environment Agency interfaces with the SET base, the Agency aims to draw up a Science Plan to provide a more transparent structure for this interface. This Science Plan will be available for reference by external organisations and should assist in establishing productive, and appropriate, partnerships on specific issues with academia.

12 June 2000

APPENDIX 26

Memorandum submitted by the Confederation of British Industry

1. We would like to make the following brief comments on the current inquiry by the Select Committee. We also draw the Committee's attention to the attached document, which the CBI submitted to the Minister for Science earlier this year. The attached paper was the CBI's contribution to the consultation on the much anticipated Science and Innovation White Paper[27].

FORWARD LOOK

2. The annual publication of Forward Look to provide a clear and up-to-date statement of the Government's Strategy for science, engineering and technology (replacing the more limited annual review).

3. The Forward Look has developed significantly since its inception and is a useful resume of Government policy, covering Departments, Research Councils and a few other bodies. The most valuable aspect is the statistical review (of finances and other data). The long time series of data on most tables is welcome as is the attempt to show real term changes over time by back calculating the effects of inflation. This is a useful document for policy work and its continuance should be supported.

FORESIGHT

4. The creation of Technology Foresight (now Foresight), designed to "achieve a key culture change: better communication, interaction and mutual understanding between the scientific community, industry and Government Departments".

5. The CBI has expressed support for the continuation of this exercise. It serves a valuable role in getting interested parties together to think constructively and imaginatively about future challenges, opportunities and research requirements. The challenge is to ensure the outcomes of the current exercise can be translated into actionable points and priorities. In particular the findings must be made more accessible to more than just the "usual club" of research intensive companies if the full potential of the exercise is to be realised.

TECHNOLOGY TRANSFER

6. A shifting of emphasis for technology transfer initiatives to place more importance on "the interchange of ideas, skills, know-how and knowledge between the science and engineering base and industry".

7. Greater effort still needs to be put into ensuring that research, skills and ideas locked up in the UK science base are turned into innovative products and services by UK companies. We have commented extensively on this in our submission to the Office of Science and Technology consultation on the new White Paper (see Annex).

SMEs AND INNOVATION SUPPORT

8. Programmes to improve access for small and medium-sized enterprises to innovation support programmes.

9. The CBI has welcomed the recent changes in tax incentives for SMEs to encourage research and development. Other changes providing better business support and encouragement for innovation have also been somewhat successful. However, we do have concerns about the number of initiatives that seem to get introduced and whether they are as successful as might have been hoped. A partial solution to this is to consider best practice and successful ideas from other countries and whether they might be applied here to similar or greater effect. For instance, we note the success of the Small Business Innovation Research (SBIR) programme in the USA which gives valuable government contracts to smaller innovative companies. We have expressed support for considering a UK-version of SBIR in our White Paper submission to the OST.

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[27] Not printed.

COUNCIL FOR SCIENCE AND TECHNOLOGY

10. The abolition of the Advisory Council on Science and Technology and its replacement with the Council for Science and Technology "to help ensure that the Government benefits from outside independent and expert advice when deciding on its own research spending priorities".

11. The CST appears to have been largely invisible since its creation. Only recently have we been made aware of its activities and publications. We do see a role for a group that can take a national strategic overview of science base and innovation issues, but the CST may not be the right model. Again, we comment on this in the attached paper[28].

RESEARCH COUNCILS

12. The reorganisation of the Research Councils with modified management structures and new mission statements which made more explicit their commitments to wealth creation and the quality of life.

13. The new Research Councils took a while to settle down and there were concerns that a silo approach to research funding would be the end result. However, in general, this has not been the case. Structures are now slowly coming into place to manage multi-discipline and multi-research council applications and recent moves towards making this easier (eg with an individual research council taking the lead if most of the proposal falls within its remit) are welcome. Of course, improvements could still be made on how initiatives that are common to more than one Research Council are delivered.

14. We welcome the moves towards more responsive mode funding, the creation of peer review pools and initiatives to invite industry and other research users to take an active part in review and direction setting.

15. So far, the balance between wealth creation and quality of life activities has been about right. We note that the boundaries between these two aims are becoming increasingly blurred as the UK seeks to exploit research and new technologies that will bring profits and, for example, improve health or the environment.

16. We do not see any requirement for major changes in the Research Councils so long as they continue to develop their close working relationships with each other, with the research community, and with research users. Our main concern is to ensure that the Research Councils fully cover the cost of overheads relating to the research projects that they fund.

DIRECTOR-GENERAL OF RESEARCH COUNCILS

17. The creation of the post of the Director-General of the Research Councils and the absorption of the functions of the Advisory Board for the Research Councils into the Office of Science and Technology.

18. This post has been essential in co-ordinating the activities of the Research Councils, ensuring that they work together and maintain an approach that is both strategic and cost effective. The post benefits from being occupied by an industrialist who can think about long-term innovation and research while also thinking about shorter-term priorities and applicability.

PUBLIC UNDERSTANDING OF SCIENCE

19. The launch of a new campaign to spread understanding of science among school children and the public.

20. It is important that science remains a core part of the national curriculum at both Primary and Secondary levels and that all school leavers have a good understanding of science if they are to make effective and informed decisions in the modern world. Progress at Primary level has been encouraging and the UK scores relatively well in international comparisons of school-level science. However, we do have concerns about whether double award science at GCSE is an effective preparation for later learning. Greater encouragement needs to be given to students to study science, maths and engineering at higher levels and to consider such subjects as potential career choices.

21. In terms of the wider public understanding of science this has perhaps been the least successful aspect of the 1993 White Paper. Despite efforts with "Science Week" and greater publicity for the work of the British Association, confidence in science has been hit by a range of "news worthy" issues that have damaged public trust. This is not something that can be solved overnight, but instead requires renewed and co-ordinated efforts involving industry, government, the professional bodies, teachers, the media and a range of other opinion formers.

15 February 2000

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[28] Not printed.

APPENDIX 27

Memorandum submitted by The Royal Society

SUMMARY

The statement of aims in the Government's "Science and Innovation Strategy" consultation document is too narrowly focused on certain aspects of the role of science in wealth creation, and lacks the breadth of intentions required for a national science strategy.

In order to ensure and maintain the excellence of the UK's Science[29] Base, a strong commitment to improving academic pay and conditions and investing in infrastructure is required, ideally through a plurality of funding sources.

It will be difficult to arrest and reverse the damaging drop in expenditure on research and development by Government Departments unless each Department regards support for a world class Science Base to be part of its mission, and invests accordingly.

The most important asset and output of the Science Base is skilful and knowledgeable people, and this must be made clear in a national strategy for science.

The Government must recognise in a national strategy for science that the aims of wealth creation and improving quality of life are both vitally important.

A national strategy for science should include as an aim the promotion of a dynamic interaction between scientists and the rest of society.

INTRODUCTION

The Royal Society welcomes the opportunity to contribute to this inquiry. This submission has been prepared by a working group chaired by Professor David Wallace CBE FRS (Vice-Chancellor, Loughborough University) and consisting of Dr Jonathan Blackburn (Dept of Biochemistry, University of Cambridge), Professor Michael Brady FRS (Dept of Engineering Science, University of Oxford), Professor Julia Higgins CBE FRS (Dept of Chemical Engineering, Imperial College of Science, Technology and Medicine), Dr Steve Howdle (School of Chemistry, University of Nottingham), The Lord Hunt of Chesterton (Dept of Space and Climate Physics, University College London), Sir John Kingman FRS (Vice-Chancellor, University of Bristol), Professor Anthony Ledwith CBE FRS (President, Royal Society of Chemistry), Sir John Skehel FRS (National Institute for Medical Research, Mill Hill, London), and Dr Michael Stowell FRS (Dept of Materials Science and Metallurgy, University of Cambridge), with support from Dr Mark Scott (Royal Society), Mr Bob Ward (Royal Society) and Ms Kirsty Brown (Royal Society). The submission has been endorsed by the Council of the Royal Society.

Although the Committee has identified a number of questions to which it is seeking answers, this submission focuses on two questions:

- Do you agree that the aims listed in the Government's recent consultation document on "Science and Innovation Strategy" are appropriate for a national strategy for science?
- What do you believe should be the main features of a modern strategy for science, engineering and technology, and why?

AIMS OF A NATIONAL SCIENCE STRATEGY

We note the following statement from the "Science and Innovation Strategy" document:

> Innovation is the successful exploitation of new ideas, products, materials, techniques and processes. It covers new ways of performing old tasks, new ways of using old materials and new working methods in long established businesses, in manufacturing and services. Poor performance in innovation has long been a problem in many parts of UK industry. The Government now plans to tackle that problem through action to:
>
> - sustain the excellence of the science and technology base;
> - encourage private investment in innovation;
> - streamline knowledge transfer schemes and focusing them on clear goals;
> - foster regional networks;
> - improve the flow of skilled scientists and engineers to industry;
> - improve the ability of the science base to play a role in the knowledge economy;
> - take advantage of the globalisation of research; and
> - improve public confidence by creating greater transparency in the regulation of science.

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[29] References in this document to "science" mean "science, engineering and technology", unless otherwise indicated.

This statement lacks the breadth of intentions that was encapsulated in the strategy outlined in paragraph 8.2 of *Realising Our Potential.* The new aims are too narrowly focused on certain aspects of the role of science in wealth creation, and neglects other important goals. We identify here some of the most important omissions.

The Science Base

We welcome the stated commitment to ensuring and maintaining the excellence of the UK's Science Base. But if the Government is to translate its good intentions into real outcomes, there are two issues that it must face.

It is our conviction that problems with pay are arising in almost all grades within UK academia and that uncompetitive salaries are making it more difficult for higher education institutions (HEIs) to recruit and retain the best scientists. The HE sector has achieved the substantial growth in student numbers during the last decade through increased productivity: between 1989–90 and 1997–98 the unit funding per student declined in real terms by 35 per cent. Despite these efficiency gains, staff salaries have continued to decline against those of similar professional groups. Under the current funding arrangements for the sector, HEIs are now expected to make further efficiency gains of one per cent each year, against inflation, with a larger gap against national salary increases. These constraints make it difficult for universities and colleges to tackle the problem of pay. Additional funding will be required from public and other sources to ensure that HEIs can recruit and retain the right calibre of staff required to preserve the UK's world class Science Base.

But competitive pay and conditions are not the only factors required to attract the best scientists to the UK Science Base. World class scientists require world class equipment and facilities. Sadly, the infrastructure of the Science Base, relative to the number of people it supports, has suffered a perilous decline because of acute under-investment. The creation of the Joint Infrastructure Fund (JIF) following the Comprehensive Spending Review provided much needed funding to tackle the years of neglect of laboratories and equipment. The injection of such sums of money is very welcome, but their appearance after so many years of under-investment has not been without cost. The percentage of applications to the JIF which have been supported has been low, so that HEIs have diverted significant resources towards the preparation of substantial numbers of unsuccessful bids. In a number of cases, when a bid has been successful, the award of funding has been made as partial contribution towards a particular facility and without due regard for the bidder's strategic priorities. Consequently some HEIs have had to divert their hard-pressed financial resources towards lower priority facilities in order to cover the shortfall from the JIF awards.

The decline in the Science Base's infrastructure has occurred over a long period, and can not be remedied overnight. World class infrastructure requires substantial funds on a continuous basis. A national strategy for science must include a long-term plan for ensuring appropriate investment in infrastructure, and we expect JIF to signal the beginning, not the end, of this process. The strategy must consider where this investment is best directed. For instance, in future JIF should be administered in a way that recognises more explicitly the strategic objectives of individual HEIs and an overall national strategy. And as the recent experience of the process of site selection for the DIAMOND synchrotron source has illustrated, the Government should also develop a clear strategy for building and maintaining major facilities.

Given the difficulty of consistently selecting good research and good researchers for funding, and the explicit and implicit constraints imposed by the selection criteria for any funding line, the Science Base is in principle strengthened by having a plurality of funding sources, mechanisms and criteria. Each funding source has its own set criteria. What is essential for the overall health of the Science Base is that the various funding sources reinforce each other. What has actually been happening is that one source (the Funding Councils) provides the infrastructure (meaning here salaries of core staff, buildings, routine consumables etc rather the major items funded by JIF) and the others (Research Councils, other streams of Government funding, sources from the European Union, charities and industry) provide project funding; but, over the years, project funding has greatly outgrown infrastructure funding and the whole system is now under massive pressure as a result. The balance between the various funding sources, and the health of the system as a whole, need careful monitoring. It may be that the traditional separation of infrastructure and project funding needs to be reconsidered.

Support for the Science Base by Government Departments

Other government departments do not regard support for the Science Base as part of their missions. The sharp decline in expenditure on research and development (R&D) by the civil departments, excluding the Science Budget and funding through the Higher Education Funding Councils, over the last 15 years suggests that not all, if indeed any, departments now believe that they should contribute to sustaining a world class Science Base. R&D expenditure by the civil departments (excluding the NHS) is projected to be 52 per cent lower, in real terms, in 2001–02 than it was in 1986–87. Coupled with the drop in defence R&D expenditure, this means that the proportion of UK R&D funded by government has fallen from 35.4 per cent in 1988 to 30.8 per cent in 1997. This figure is lower than for any other G7 country except Japan (and there the figure has risen from 16 per cent in 1991 to 21 percent in 1995). It is not evident that such a policy is in the interest of the UK.

In 2001–02, R&D expenditure by the Ministry of Agriculture, Food and Fisheries is planned to be 34 per cent less in real terms than in 1986–87, and the Department of Trade and Industry plans to spend 66 per cent less than the combined expenditure of the Department of Trade and Industry and Department of Energy in 1986–87. Without examining in detail the R&D policies of each Department, it is impossible to judge how far these expenditure trends reflect Foresight priorities or Ministerial objectives, let alone whether they are in the best interests of the UK. But the net outcome of these individual decisions, coupled with the investment decisions made in the industrial sector, is that the UK spent only 1.80 per cent of its gross domestic product on R&D in 1997, compared with 2.09 per cent in 1993, the year in which *Realising Our Potential* was published. We believe that the UK's R&D expenditure is currently too low for a country trying to compete globally in a knowledge-driven economy.

There are well known arguments for associating R&D budgets for specific purposes (eg health, agriculture, environment, etc) with the Departments charged with overall responsibility for those purposes. Equally familiar are the reasons why such a policy, coupled with traditional Whitehall territoriality, makes it difficult to deliver a single coherent approach to government expenditure on R&D as a whole. This has been exacerbated in recent years by the practice of relying on "internal markets" within each department to drive the use of departmental R&D budgets: it has become all the harder to influence these budgets from the outside. Within each department, there needs to be a strong group defending the R&D budget and using it effectively. This must be linked to a strong voice for R&D at cabinet level.

It will be difficult to arrest and reverse this damaging drop in R&D expenditure unless each government department accepts that its policy objectives depend upon a world class Science Base. Each government department should then include support for a world class Science Base in its Mission, and should invest accordingly. This far-sighted approach, if acknowledged in a national strategy for science, would help the departments to achieve other parts of their Missions. Many departments turn to the Science Base for policy guidance. This will be available only if the UK Science Base is diverse and healthy enough to nurture new ideas and to stay at the forefront of global developments in science.

THE ROLE OF THE OFFICE OF SCIENCE AND TECHNOLOGY AND ADVISORY BODIES

The Office of Science and Technology has a pivotal role in advising on departmental R&D spend and in co-ordinating such expenditure across government. We believe that OST has achieved significant progress, notwithstanding the low overall level of investment in R&D, with these roles in recent years, for example in setting in place co-ordinating machinery at Ministerial and at official levels. We note with interest the establishment of the Chief Scientific Adviser's Committee, which, among other things, provides collective advice to Ministers through the Ministerial Science Group. It is clear that the new Committee faces major challenges in improving the handling of issues that affect several departments.

We also wish to draw attention to the importance of the Director-General of Research Councils (DGRC) having access to independent advice. *Realising Our Potential* stated that "the Director-General will be advised by a small standing group of independent experts selected to allow him or her to draw upon the requisite scientific, economic, industrial and management expertise in considering the baseline programmes, corporate plans, longer-term prospectuses, and performance of the Research Councils". The establishment of such a group would assist the DGRC in his efforts towards the achievement of the aims of a national strategy for science.

It is difficult to assess the impact of the Council for Science and Technology, which replaced the Advisory Council on Science and Technology after publication of *Realising Our Potential.* It may be beneficial to make more widely known the role of the CST and how it relates to the other bodies advising government.

This seems like several advisory bodies doing quite closely related tasks. It may be timely to review whether a degree of collaboration, or even merger, would improve the overall effectiveness of the system.

THE SCIENCE BASE'S MOST IMPORTANT ASSET AND OUTPUT: KNOWLEDGEABLE AND SKILFUL PEOPLE

The most important asset of the Science Base is inventive, knowledgeable and skilful people, and this must be made clear in a national strategy for science. To ensure that a steady flow of people enters the Science Base, science must pervade all levels of the formal and informal education system. The critical first step is to enthuse the young about science.

Science education provides pupils with knowledge of the natural world, the skills of investigation and experimentation, and an appreciation of the importance of science to individuals and society. Science can also develop such personal skills as curiosity, motivation, teamwork and the ability to communicate. These skills and values help prepare pupils for further study and a broad range of careers, as well as providing a basis for informed citizenship.

Scientists and engineers from both academia and industry have an important role to play in supporting the professional development of science teachers and giving pupils an accurate image of life in science, providing ideas, resources and real contexts for science activities. Partnerships between active scientists and schools can yield significant benefits for teachers, pupils and the scientists themselves.

But the teaching of science should not be regarded only as a means of meeting the needs of the Science Base and industry. A high level of scientific literacy among a wide range of people will allow society to understand and appreciate the benefits and limitations of science, an increasingly important feature of a modern democracy.

A flow of talented people into universities and colleges ensures the high quality of the output from the Science Base, in the form of skilled scientists and knowledge, on which successful industry is so dependent. Four further points need to be considered.

First, the flow between the Science Base and industry has been helped by initiatives such as collaborative research grants, engineering doctorate centres, industrial CASE awards, Faraday centres and special funding for PhD students to spend an additional year in industry. The Government's emphasis on lifelong learning is also particularly relevant for scientists and engineers, given the pace of technological change. We welcome initiatives such as the Higher Education Reach-out to Business and the Community Fund, jointly established by the Higher Education Funding Council for England, the Department of Trade and Industry, the Department for Education and Employment and the Department of Education Northern Ireland, and the concept of flexible postgraduate training accounts pioneered by the Engineering and Physical Sciences Research Council. Such schemes should be expanded.

Second, the Science Base has a proud record of serving the needs of industries based on physical and biological sciences, and of contributing to the UK's quality of life, not least through developments in the medical and plant sciences. Increasingly, scientists and engineers will be of value in the financial services, leisure and creative industries.

Third, it is valuable to have flows of people in many directions. The Science Base needs a flow of knowledgeable people from industry, so that there is free exchange of ideas between industry and HEIs. There are numerous cases, particularly in information technology, where people educated in the humanities or social sciences have become skilled in science. We welcome this and believe that a national strategy for science should encourage schemes to support the retraining of people to provide them with scientific knowledge.

Finally, *Realising Our Potential* identified another significant problem with the flow of knowledgeable people to and from the Science Base. It stated:

> Women are the country's biggest single most under-valued and therefore under-used human resource. The Government believes that there is massive scope to attract more women into science and engineering.

This problem was examined in more detail in *The Rising Tide* in 1994. Although there have been some attempts to address the factors preventing women from realising their potential in science at all levels, much more needs to be done. A national strategy for science must address this issue, and it would be timely for the Government and the scientific community to consider together what progress has been made since publication of *The Rising Tide,* and what further action needs to be taken.

WEALTH CREATION, INNOVATION AND THE SCIENCE BASE

Basic research can and does contribute to innovation in ways that are often unforeseen and science is a basis for more innovation in industry and commerce than is generally recognised. The Research Councils have taken forward the need to support wealth creation in industries drawing upon classical disciplines such as the physical and biological sciences. However, the very essence of much innovation today is that it does not fall into classical categories, yet it still needs to be underpinned by the science base. A national strategy for science must address the need to invest in basic research in new disciplines and across disciplines and the application of ideas from the science base to non-traditional areas such as financial services, even though these are not naturally represented by one of the Research Councils. To this end, we welcome the recent emphasis on initiatives across Research Councils, and would encourage their expansion.

Technology Foresight, re-launched as Foresight on 1 April 1999, is intended to promote links between business, science and government to identify future needs, opportunities and threats. It is not clear that all of the sectors of academia, industry and commerce that can benefit from this initiative have embraced it with enough enthusiasm.

Support for innovation is best focused on giving incentives to entrepreneurs to innovate, and removing barriers. We welcome, for example, the concessions on Capital Gains Tax for start-up businesses. It is less efficient for Government to try to build directly the capability of firms to undertake innovation that is, by its very nature, extremely varied.

SMART and the Teaching Company Scheme are important sources of pre-product funds for start-up and small companies. They are of proven worth and should continue to be extended both in scale and in scope. A relatively small investment in increased seed funding here could increase innovation markedly.

The vast majority of start-up companies need to identify and protect their intellectual property. The Government's University Challenge has made an excellent start at encouraging the identification and initial protection of intellectual property rights (IPR) emanating from the science base. However, we note the huge and often unaffordable costs of patenting IPR in Europe, because of the need to conform to each individual national framework. A national strategy for science should include plans for the Government to take the lead in pressing for harmonisation of IPR legislation in Europe, so that a patent may be lodged in only one European Union country, yet will be recognised and enforceable in all Member States.

Some IPR is best protected by non-disclosure and confidentiality agreements (NDCAs). However, if they try to prove breaches of a NDCA, small companies are always at the mercy of those with deeper pockets. There is no equivalent of the Legal Aid system for small and medium sized enterprises (SMEs). We believe a national strategy for science should include plans for the Government to investigate the idea of an "IPR legal Aid" scheme to support SMEs in cases arising from alleged breaches of NDCAs.

Quality of Life and the Science Base

Wealth creation is only one of the outcomes from the application of science that were identified by *Realising Our Potential.* The other, an improvement in the quality of life, is equally, if not more, important. In an article in *The Independent on Sunday* on 27 February 2000, the Prime Minister, in commenting on recent advances in biotechnology, wrote:

> The challenge for scientists is to demonstrate that they can use these advances not just for making profits for firms but to improve the lives of people. The challenge for governments is to provide the highest level of protection for human health and the environment.

We believe that, if there really is a perception that scientists are focusing too much on wealth creation and not on improving quality of life, then the Government itself must also bear much of the responsibility. The consultation document for the new White Paper examines the role of science in improving innovation in industry, but does not emphasise the importance of science in improving quality of life.

Some areas, such as drug development and combating crime, provide the potential for improving quality of life as well as being commercially attractive. The Government must recognise that a national strategy for science should address both wealth creation and quality of life. It is not clear if this will be possible if the national strategy for science is considered only to be a subsidiary part of the mission of the Department of Trade and Industry.

Science and Society

Many within the scientific community have recognised the need to look beyond the public understanding of science. As highlighted in the report on "Science and Society" by the House of Lords Science and Technology Select Committee, scientists and other parts of society must engage in a constructive dialogue to overcome what has been described as a "crisis of confidence in science".

Certainly greater transparency in the way science is regulated is required to preserve the scientific community's "licence to practise", but such a measure only addresses one of the many challenges facing the scientific community in its quest to cultivate the public's trust. A national strategy for science should outline ways to promote a dynamic interaction between scientists and the rest of society.

The Committee on the Public Understanding of Science (COPUS) could play a key part in promoting a dialogue between science and society. Its future role is to act as a national focus for organisations and bodies involved in promotion of science in the UK. In order to undertake this new role; the sponsors of COPUS (the Royal Society, the Royal Institution of Great Britain, and the British Association for the Advancement of Science) will disband the existing Committee, replacing it with an expanded membership to include a broader representation from the engineering sector, social scientists, the museums and visitor centres, charities, trusts, learned societies and other key players. The new Council will monitor national developments, share and disseminate best practice, and seek new mechanisms for engaging the public in the development of science policy and the applications of science in an informed way. A national strategy for science should acknowledge this.

14 June 2000

APPENDIX 28

Memorandum submitted by The Geological Society

The Geological Society, founded in 1807, is the oldest geological society in the world. It has almost 9000 members worldwide, and is both a learned and professional body, recognised by the DTI as the chartering authority for appropriately qualified Fellows.

1. The Society's evidence focuses on:

— the Government's strategy for science

— Foresight

— the public understanding of science

THE GOVERNMENT'S STRATEGY FOR SCIENCE

2. The extractive industries in the UK (including hydrocarbons and coal) accounted for 1.7 per cent (£12.75 billion) of the UK's GDP in 1998. Geoscientific knowledge and expertise underpins much of the work of these industries, and also has a major role to play in addressing environment issues, such as the restoration of the contaminated land, waste disposal, water supply and quality, coastal retreat and climate change.

3. In its recent evidence to the Committee's inquiry into "The Scientific Advisory System—Scientific Advice on Climate Change", the Society drew attention to the need for a stronger geoscience perspective to be included in government research into the effects of global climate change, and the need for more studies of the consequences of volcanic winters. These are two examples that illustrate our general concern that government needs to pay more attention to the contribution of the geosciences to policy making concerning sustainability and the environment.

4. We are concerned that the 1993 White Paper, with its focus on wealth creation and the quality of life, has resulted in under-investment in the acquisition of baseline data collected by the British Geological Survey, research institutes and universities. Such information is essential to formulate and implement policies concerning sustainability and the environment at national and local levels. Examples include:

— Maps of geology, hydrogeology and potential hazards (due to natural geological conditions and mining).

— The acquisition of time-series data showing changes in climate, groundwater conditions, coastal retreat and advance, and ecological change, not only in recent and historical times, but also over much longer periods of time (thousands to millions of years) before the impact of major anthropogenic changes. Without such data, there is little, or no, objective basis on which to measure change, and to begin to separate out anthropogenic from natural changes.

5. Many advances in the geosciences in the last century contributed to wealth creation and the quality of life in a long-term strategic fashion, but might well have failed this test of success if the originators had not been free to undertake "blue skies" research. Many of these advances were interdisciplinary in nature, and the same will apply in future. It is important, therefore, that future research funding is not "discipline blinked". Competition between individual scientists and groups may be healthy, but competition between grant giving Research Councils based on pre-judged "areas of science" may not be the best way of achieving value for money.

FORESIGHT

6. The Society has the impression that so far Foresight outputs have had a rather limited impact on geoscience related business, and that they are not widely known amongst our membership, 60 per cent of whom work in industry and commerce. Not surprisingly, therefore, in 1998, in its response to the OST's consultation on the next round of Foresight, the Society expressed strong reservations about the wisdom of combining the Energy Panel with that dealing with Natural Resources and Environment. The relatively new Energy and Natural Environment Panel has, as far as we know, yet to act on suggestions for geoscience-related topics to address, such as aggregate production and use, and landfill siting and containment strategies. Such problems once again highlight the difficulties of expecting research to yield immediate effects on wealth creation and the quality of life (see paragraph 4).

7. In its 1998 response to OST, the Society proposed that the panel addressing "Education, skills and training" should consider the implications of sustainable development. We suggested much more needed to be done, particularly at school level, to ensure that all citizens have a broad knowledge and understanding that our quality of life and that of future generations is dependent on the wise use of renewable and non-renewable resources. Foresight outcomes, therefore, should provide a business/industry perspective on the changes needed to school and university education and training, and to the provision of life-long learning, in order to achieve sustainable development. We are not aware that the panel has pronounced publicly on these issues.

PUBLIC UNDERSTANDING OF SCIENCE (PUS)

8. *Realising our Potential* gave a most welcome fillip to the standing and practice of PUS activities and charged the newly formatted Research Councils with providing financial assistance to that end. However, the paradigm remained unchanged from the Bodmer Report (1985) of the Royal Society—scientists communicating to the public. The world has since moved on. What is required now, as Her Royal Highness, the Princess Royal, said in opening Science Week in March this year, is a process that will enable the average citizen to feel that the products of research and science will "empower, not imprison them". This will need a genuine dialogue involving a willingness on both sides, to address, as it were, the other side's examination paper as well as answering their own.

9. The geoscience community has long experience, through public enquiries and the like, in understanding public reactions to the exploitation of their subject in new proposals for quarrying, for radioactive waste disposal, for new transport routes, etc. and in providing a sound basis for informed debate. These examples are all issues with which Government and Parliament are much concerned. The challenge, as we see it, is, therefore, to find the appropriate national and local institutional framework(s) through which scientific, social and political inputs to major public policy issues can be discussed in an open, responsive and non-adversarial manner. To do this requires new kinds of PUS activities aimed at developing dialogue both between scientists and the public, and scientists and government.

10. The Geological Society plans to increase its educational activities in collaboration with other organisations, and the delivery of these will be designed in the context of the comments in paragraphs 4, 8 and 9. We look to government and to non-governmental organisations alike to help develop a genuinely two way dialogue. Museums and Science Centres, consensus conferences and internet exchanges could provide some of the more obvious vehicles for the dialogue, given the necessary resources. But it will be active encouragement by a Government genuinely seeking transparent debate and policy input, from public and science together, that will be the key to dialogue.

APPENDIX 29

Memorandum submitted by the Medical Research Council

1. INTRODUCTION

1.1 The Medical Research Council welcomes this opportunity to contribute to the Science and Technology Committee's deliberations on *Realising Our Potential* and the proposed Science and Innovation White Paper. A great deal of progress has been made since 1993 in addressing the concerns that prevailed then:

- the UK has, in OST, a proper mechanism for handling science policy and funding issues across government;
- there is greater clarity about the strategic roles of the Research Councils;
- funding for the biomedical science base is now oriented towards more stable, multidisciplinary structures with greater critical mass;
- there are more opportunities for young biomedical researchers to obtain longer term positions, through personal awards and grants;
- new partnerships between the science base and users, and between funders have formed, providing greater returns on investment;
- pathways for commercial exploitation of publicly funded science have been greatly enhanced;
- science has, for better and sometimes for worse, achieved a higher profile in people's minds, and most scientists now give a higher priority to explaining their work to non-scientific audiences, and are more skilled at communications.

Some of the changes made by MRC since 1993 are discussed in more detail below. The bulk of this submission, however, considers the facts, viewpoints, and concerns that need to be taken into account in developing UK science policy for the future. In some areas, such as the attractiveness of scientific careers, there is still a great deal more to do to ensure the UK can maintain and exploit its international pre-eminence in science, and in other areas, such as public understanding of science, it is time to acknowledge the limitations of the approaches emphasised in *Realising Our Potential.*

1.2 Our comments below are in six sections:

(2) Research Council's governance, leadership and strategies.
(3) Scientists' training and careers.
(4) Ways of supporting the science base.
(5) Exploitation and Application.
(6) The public's relationship with science.
(7) International science.

1.3 Given the range of issues covered by the enquiry, it is only possible to offer a summary of MRC's viewpoint here. We would be happy to elaborate on any of the topics, orally or in writing, or to provide supporting data.

2. OST, Research Councils' Governance, Leadership, and Strategies

The Office of Science and Technology

2.1 With hindsight, the formation of an Office of Science and Technology to replace ABRC was justified. OST has provided a focal point for discussion of science issues within government, and has helped deliver clearer and more decisive proposals in spending reviews. It has a role that is essential to a country seeking a knowledge based economy and modern, effective public services.

2.2 The presence of OST has also helped to facilitate joint initiatives across Research Council boundaries. Co-operation to rationalise London Offices, develop common systems of grants payment administration, share internal audit function, and co-operating in procurement, have all helped improve Council" administrative efficiency. Especially since the 1997 Comprehensive Spending Review, OST has also developed strategies to encourage and aid scientific co-operation (see below).

2.3 The disadvantages of having a more centralised science administration are that lines of communication between science and Government are longer and more complex, and that the relative roles of the various parts of OST (and relevant parts of DTI) and the Research Councils are sometimes obscure. The presence of OST has meant that Research Councils are less likely to be consulted in policy debates, even when the issue depends on consideration of specifics that vary between research sectors, rather than general policies and trends. There is also an increased tendency for other organisations to see Research Councils as simply a section of Government, rather than as bodies that can assemble and distil distinct and independent advice from a broad cross-section of stakeholders, which is not easily accessible to a central office. These problems may be felt more acutely by MRC than by other Research Councils, partly because stability over the last few decades has allowed us to develop a very strong role in representing and leading the medical research sector, and partly because medical research strategy has to address the rapidly growing charity sector, and national health needs and health service structures, as well as more general policy issues.

The mission and role of Research Councils

2.4 The White Paper's principles for public sector research funding, and the organisation of Research Councils, have proved sound. At the same time as highlighting the importance of user relevance and strategic decision-making, the Paper restated the Haldane principle that detailed decisions on scientific strategy and research funding should be taken by Research Councils rather than by government. It also re-affirmed the need for scientific excellence as the prerequisite for public sector funding—"second rate research is a poor buy"—and that the main role of public funding should be in supporting basic and strategic research. These principles have continued to be applied in practice, and have served the UK well. They should remain central to UK science policy.

2.5 At the time of the White Paper, during the 1994–95 Technology Foresight exercise, and when OST moved from the Cabinet office to OST, many people in the science-based industry expressed fears that research funding would be more centrally directed, and oriented to short-term industry needs for applied research, rather than longer term goals of innovativeness and social benefit. These fears were not realised, but consumed a considerable amount of time and energy that could have been avoided by more considered and consistent explanation of policy at the outset.

2.6 The White Paper defined six mission-oriented Research Councils, in order to allow vertical integration between basic and strategic or applied research in each sector, and to ensure policies were tailored flexibly to the needs of each sector and it stakeholders. Trends since 1997, and in particular the pace of progress in genetics and molecular biology, means that vertical integration with functional and clinical studies is more important now than ever before. Vertical integration is central to our strategies for the Post-genome Challenge and Health of the Public. At the same time, a high proportion of MRC's most important activities involve developing policies and practices that are specific to the needs of the biomedical sector. These include:

- MRC's funding schemes, which use Centre Grants and Co-operative Grants to support infrastructure, and build multidisciplinary and vertically integrated groupings with critical mass.
- MRC's work with the Health Departments on research support in the new NHS.
- MRC's training and career schemes, which take account of the highly competitive international employment market for biomedical researchers, and the special needs of researchers who are also doctors (or other health professionals).
- Progress in technology transfer, where the ability of biomedical industry to exploit basic research findings leads to approaches that are very different to those in other sectors.
- MRC's role in strengthening high quality, responsible clinical research by developing operational and ethical guidelines.

Each of the other Research Councils works with similar, sector specific issues, ranging from the challenge of delivering access to extraordinarily costly facilities needed for atomic structure research, to the challenge of promoting knowledge transfer from social and economic research to practice and policy.

MRC's strategic decision-making

2.7 A major theme of *Realising Our Potential* was the need for clear strategies and priorities in funding research and training, and for these policies to reflect user needs, and to be as explicit and open as possible. MRC already took a strategic approach to research management—for example, in developing Health Services Research through the 1980s and in pump priming the Human Genome effort in the UK. Since 1993 we have developed this further:

- internally, we strengthened planning mechanisms, and refined our tactics for implementing strategic initiatives;
- we maintained formal Concordats with the Health Departments and the Department for International Development (then ODA) (highlighted as a model in *Realising Our Potential*), which have had an important input to MRC priorities, and established new Concordats with MAFF, DETR, DTI, and MOD;
- we strengthened industry representation on MRC committees;
- we produced more accessible and user-friendly definitions for scientific strategy and funding priorities, and published them on the Web.

The move to a three-year funding cycle within government has also helped longer-term planning.

Partnerships

2.8 Partnerships with other funders is now a pervasive feature of our strategic planning. For example MRC has:

- worked with The Wellcome Trust on some major projects, including the development of the Sanger Centre and the current plans for a National Biomedical Collection of up to 500,000 donated DNA samples. We co-ordinate activities with The Wellcome Trust in many other areas;
- developed closer links with the research charities, most notably to establish the MRC/Cancer Research Campaign Collaboration in Cambridge in 1999.
- participated in new cross-Research Council initiatives, such as funding for centres in tissue engineering and medical informatics, and new programmes for research in metrology, to encourage physical science graduates to develop careers in biomedical research, and studies of the social, organisational, and economic impacts of new health technologies.
- established closer operational links with the Higher Education Funding Council for England, and agreed a Concordat with the Welsh Assembly which encompasses their University funding policies.
- facilitated or led agreements on large-scale, long-term industry funding for centres of excellence in areas such as vaccines research, imaging, mouse models of gene function, and cell signalling—investments which are likely to be more valuable to the economy and to the science base than more dispersed, smaller scale contracts.

2.8 Some of these partnerships are the result of a natural tendency for scientific fields to merge to create new opportunities—such as the opportunities emerging in biomedical informatics. However, these partnerships also play other important roles, helping vertical integration of basic and applied research in areas where MRC and charities support complementary programmes, and creating centres with greater critical mass than would otherwise be possible.

Foresight

2.9 MRC supported the principle of Technology Foresight when the White Paper was launched, and we gave substantial support to the creation and work of the Health and Life Sciences panel. Following the completion of the exercise, we built the Technology Foresight reports into our 1995 strategy review, launched two new LINK programmes, and helped develop new Foresight Challenge collaborations.

2.10 Our assessment of the impact of the national Foresight programme in the biomedical sector is that the programme has played a part in a general improvement in academic/industry co-operation and technology transfer. It helped define and validate the main strands of thought on research priorities current at the time, helping to raise the profile of the "integrative biology" principle, and of research relevant to ageing. Especially through Foresight Challenge, it prompted some collaborations to emerge more quickly and with more commitment than might otherwise have been the case.

But overall, Foresight has had only a moderate impact on the health sector. There were already good academic-user links in place in the biomedical sector, built on the strong research-orientation of the pharmaceutical and biotech industry, and the applicability of basic medical research. We found there was a close match between MRC strategy and Foresight recommendations, and by 1996, our estimate was that at least two-thirds of our research and training investments were broadly relevant to Foresight themes.

2.11 There can be no doubt, as far as MRC is concerned, that research funders must have forward looking strategies and plans developed in consultation with researchers and users—both to ensure the quality and relevance of the research, and to facilitate uptake. Key industries and other users in our sector place a similar value on vision and strategic planning, even if the full panoply of formal foresight methods are not always used.

2.12 The decision to undertake a second round of Foresight was undoubtedly the right one, and it is encouraging that the Foresight 2000 programme includes societal benefits and problems from science and technology more explicitly, and has more time and resources available. The indications are that it should be able to contribute more than the 1994/95 exercise: MRC will be taking account of the outputs in our strategy discussion in Autumn 2000. In the longer term, the key questions will be whether national, centrally directed, Foresight programmes are the best way of developing strategic vision and partnerships, and if so, how often they should be conducted.

Regional Networks

2.13 The Science and Innovation Strategy consultation paper discusses regional networks both in the context of fostering clusters of innovative enterprises, and in the context of ensuring manufacturing companies have access to relevant expertise from the science base.

2.14 Incubators and knowledge transfer activities in the life sciences can certainly be an effective long-term investment by Regional Development Agencies. MRC's Scottish Collaborative Centre was developed within partnership with Scottish Enterprise, for instance. However, the added value from partial regional management of academic-industry links in the biomedical sector will not be as high as in some other sectors. In the pharmaceutical and biotechnology sector, most successful companies tend to cluster in regions with first-rate research Universities, and without a strong science base, the return on regional investment will be poor. Moreover, companies in the sector typically have a strong in-house R&D capacity, and are highly effective at making and developing contacts in the science base, and so less likely to need help in finding advice. We would advise giving national knowledge transfer initiatives a higher priority in this sector.

2.15 The interface between the health services and research has a stronger regional dimension. High quality clinical research in a particular condition will often depend on the presence of a substantial patient group, and first rate diagnostic and treatment facilities and services. And new research findings are most likely to be applied first in those centres that have been directly engaged in the research. MRC sees a need to develop joint strategies, involving MRC, the NHS R&D programme, NHS regions, and, often, charities, to foster centres or networks of research and service excellence in particular diseases, to ensure the combination of expertise, commitment, infrastructure and funding needed for rapid innovation. We will be discussing with the Health Departments how these ideas can be developed further.

3. SCIENTISTS' TRAINING AND CAREERS[30]

3.1 *Realising Our Potential* highlighted the fact that excessive reliance on short-term contracts to support younger researchers would weaken confidence in research careers, and reduce the productivity of some of the UK's most innovative researchers.

Since then:

- Research Councils, Funding Councils, the Royal Society, and CVCP have agreed (1996) a Concordat on Contract Research Staff setting out the standards expected in terms of career advice, training, maternity arrangements and other areas. Monitoring implementation suggests there have been modest improvements in provision and take-up of this broader support for contract staff.
- MRC has expanded funding for Fellowships and other personal awards, such as Research Professorships, to provide a wider range of career paths at all levels.
- the MRC funding schemes introduced in 1997 provide the bulk of grant funding either as long-term (5 year) awards, or as components of long-term support for Centres and Co-operatives which provide a more stable research environment and a wider range of career development opportunities for scientists and technical support staff than was previously the case.

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[30] Our comments concentrate on those trained as solely scientists. We assume that the challenge of developing a stronger cadres of clinician-researchers is outside the scope of this enquiry.

- a new Career Establishment Grant was also introduced in 1997, providing five years grant support for younger researchers who have recently been given their first university appointment. This scheme is intended to ensure new academic staff have an opportunity to concentrate on developing research programmes to the point where they can compete for funding with more established teams, and has proved very popular.
- MRC Units and Institutes have continued to provide parallel career paths for those wishing to concentrate on a full-time research career.

3.2 Despite the steps taken, we remain concerned about the attractiveness of academic research careers. The Science and Innovation Strategy consultation paper rightly states that the overall volume of scientists trained in the UK is adequate. The threats, however, are that research will fail to attract enough of the highest quality graduates, and that in highly competitive areas, such as genetics and bioinformatics, UK universities and research centres will not be able to recruit and retain enough first-rate researchers.

3.3 At postgraduate level, we need to consider further increases in the stipend, even if this means reductions in the numbers of PhD students supported. In attracting and developing the people who will lead UK science in the future, quality has to be more important than quantity. MRC is planning a widespread consultation exercise on the exact changes needed over the coming months.

3.4 The recommendations of the Independent Review of Higher Education Pay and Conditions (the Bett Committee) are being considered as part of SR2000. MRC supports the case for increases in national minimum salaries, but we also see a need for greater flexibility for individual universities (and other employers) to vary pay to reflect the recruitment and retention problems in particular research or teaching areas. In the biomedical sector, there is strong competition from industry and from the USA, and while the flow of talent into industry is highly desirable, in some areas, such as bioinformatics, the difficulty of retaining first rate people in academic research will compromise universities' capacity for leading edge research and research training.

3.5 A fresh look at universities' employment policies and manpower planning could also help make research careers more attractive by providing greater stability for staff on fixed term contracts. It should be possible to offer longer term contracts, and more active career management, to at least some of those currently employed on a series of short-term contracts.

The PhD

3.6 *Realising Our Potential* proposed the widespread introduction of Masters-level research training before a PhD, as a way of broadening post-graduate learning that offered more flexibility than a four-year PhD. Since 1993, developments in research and in employers' needs, and reductions in the amount of practical laboratory experience in some first degrees, have strengthened the case for four-year post-graduate training programmes. While *Realising Our Potential* emphasised the need for transferable skills, such as communications, teamworking and project management, post-doctoral researchers also now need competence in a much broader repertoire of research approaches and techniques than in the past.

3.7 Our pilot Research Masters programme have been successful, and we are now considering how to broaden provision. However, we expect that there will always remain a substantial proportion of graduates who will be able to complete a high quality PhD within three years, and there will be fields in which this is more common than in others. Our policy will be to offer options that are adaptable to individual circumstances.

International recruitment

3.8 For much of the last century, the UK's reputation for outstanding medical research, coupled with a healthy level of research funding from public funds and charities, meant that it was able to attract many of the best scientists from around the world to work here. Most other OECD countries have been strengthening their investment in biomedical research over the last two decades, and the UK cannot rest on its laurels. At the same time the higher costs of establishing research programmes and Universities' difficulties in offering start-up funding made moves to the UK less attractive and more cumbersome.

3.9 The UK now needs to sustain a more active approach to bringing in new people and ideas. After the last Spending Review, MRC created a new fast-track funding mechanism to make it easier for VCs to bring people from other countries to the UK. Six appointments have been made using the scheme in the past year, and in addition two scientists from abroad have come to the UK to head major MRC units. MRC will continue both approaches, and expects to make further awards this year.

4. SUPPORTING THE SCIENCE BASE

4.1 MRC's policies for supporting the science base have continued to evolve rapidly since 1993, and new response mode funding schemes were introduced in 1997. The new schemes—in particular Centre and Co-operative Group Grants—facilitate the development of multidisciplinary groupings; help develop more stable research groups with critical mass; and deliver infrastructure support more effectively. At the same time Innovation Grants, Development Grants, Career Establishment Grants, and other personal awards, help ensure that greater stability is not achieved at the expense of opportunities for new talent and ideas to develop.

4.2 Selective funding of excellent, relevant research remains a central policy, but selectivity does not require us to concentrate a higher proportion of funds in a few research-intensive universities. Co-operative Group Grants have been awarded to universities which have, overall, relatively few research active staff who were highly rated in the RAE, but where there is a concentration of excellence in a particular field. In these universities, the Co-operative Group Grants can deliver infrastructure support, that is not available from the Funding Councils, as well as raising the visibility of the research.

4.3 Critical mass, selective and efficient use of infrastructure funding, stability, and multidisciplinarity are also achieved through partnerships. MRC's Centre Grants and Development Grants provide opportunities to strengthen strategic leadership in university research, and MRC hopes that strategies for scientific direction, investment and recruitment developed in partnership will help make better use of research funds.

4.4 MRC has also acted to strengthen multidisciplinary research through partnerships with other Research Councils, and its investment in people—such as our initiative to attract physical scientists to careers in biomedical research.

4.5 In parallel, MRC officials worded with HEFCE in successive reviews of the Research Assessment Exercise, advising on options for re-structuring the Medical Units of Assessment to reflect better the multidisciplinary nature of modern research, and on options for improving assessment of applied clinical and public health research. The current fundamental review of the RAE may give opportunities for an even more flexible assessment system.

MRC Units and Institutes

4.6 *Realising Our Potential* suggested that some of the research establishments supported by government departments might be suitable candidates for privatisation. The review of Public Sector Research Establishments that followed, and the subsequent Prior Options reviews, broadened the scope of their inquiry to include some Research Council establishments. Here, the question posed was usually whether the establishment could not be equally well run by a university, rather than as part of the public sector. The reviews confirmed that:

- Units and Institutes can have a key role in complementing University research work by creating focused, mission-oriented research teams, with effective scientific leadership and professionally managed facilities and supporting infrastructure.
- MRC's management of its Units and Institutes is effective, using stringent peer review, and recycling from lower priority areas, to maintain internationally competitive research programmes. MRC Units have a typical (median) life-span of about 20 years.
- MRC's strategy of placing Units and Institutes on campus, and encouraging close links with University research, benefits both parties.

4.7 Nevertheless MRC recognises the importance of thinking radically and laterally when reviewing major investments. For example we are replacing direct funding for key imaging facilities and techniques development with joint public/industrial funding through a newly formed company. Our Strategy Development Group addresses the fundamental questions about MRC's role in a particular field, and the rationale for future direct ownership of research centres, in advance of each quinquennial review of every MRC establishment.

5. Exploitation and Application

5.1 *Realising Our Potential* put more emphasis on meeting the needs of industry through collaboration, co-ordination and Foresight, than on improving exploitation of the science base, or developing industry's capacity for innovation. Where it addressed exploitation (2.9–2.19) it emphasised access to public sector R&D by industry, rather than work by the research community to overcome the development gap and get scientific advances into practice, or, indeed, the innovativeness of UK industry. Nevertheless, some of the most impressive changes since 1993 have been in the way we facilitate commercial exploitation of academic knowledge and discoveries. Across the UK science base, awareness of commercial exploitation issues, and the commitment and professionalism with which it is pursued, have all greatly improved.

5.2 Within MRC, progress in exploiting the science in our Units and Institutes has included:

- continuing the development of our central Technology Transfer Group, which in 1999 was formed into a company, MRC Technology;
- forming the UK Medical Ventures Fund in 1998, with £40 million raised entirely from private sector investors, on the strength of MRC's track record in science and exploitation, to support start-ups and other ventures based on MRC technology;

— helping set up spin-out companies. There are now 13 companies in operation which were formed by MRC, which will directly employ over 380 people in 2000, almost all in high-skill jobs;

— expanding revenue from IPR licensing. In 1999–2000 income was £7.6 million, compared with £0.8 million in 1993–4. A major part of this revenue is from "humanised" monoclonal antibody technology which is being used successfully by a wide range of biotech and pharmaceuticals companies in new therapies for breast cancer, infections, organ rejection, and other conditions.

— forming a Scottish Collaborative Centre to act as an incubator for new ventures and collaborations from MRC research in the region.

5.3 MRC's exploitation track record since 1993 confirms that the principle of keeping fundamental and applied research within MRC's remit was right. The most successful spin-out companies and patents have been based on some of our most basic and original scientific research, but this could not have been exploited without specialised knowledge of the medical sector. MRC's size, and centralised exploitation team has also allowed us to "bundle together" intellectual property from different sources to create stronger commercial opportunities.

5.4 The UK, however, still lags behind the USA in the vigour with which it exploits its scientific excellence. Some of this may be simply because the UK entered the race later than the USA, and still has a relatively small pool of entrepreneurial expertise. But there is also still a more visible "development gap" in the UK than in the USA. By "development gap" we mean the stage at which academic research has produced potentially exploitable findings, and enough evidence to publish an important scientific paper, but where further work is needed before commercial investors can be convinced—for instance, it may be necessary to prove the results are applicable in enough situations to be commercially interesting. This can entail a substantial amount of work and expense—perhaps 6-18 months' commitment from an experienced post-doctoral scientist. Only a couple of the UK's venture capital funds are prepared to invest at this early stage. The many public funding schemes designed to promote knowledge transfer are typically targeted to support collaborations with existing commercial work, incubators, or entrepreneurial skill development, but direct funding of this risky seedcorn stage is limited: indeed the 1993 White Paper emphasised that public funds should normally be reserved for more basic research, and did not envisage exceptions in this area. MRC can sometimes provide seedcorn funding at this stage—this has been a function of our Collaborative Centres from the outset—but the sums available from MRC and through university incubators can only meet a fraction of the demand. We consider there is a strong case for additional public funding in this area: rather than add to the large number of special, targeted schemes already in existence, the funds should flow through existing mechanisms with the capacity to judge scientific merit and to quickly bring scientific expertise to bear on particular problems—ie through universities and Research Councils.

5.5 This is not the same as saying that the UK is generally weak at applied research. There are many areas of applied research—such as public sector clinical trials and health services research—in which the UK science base is internationally outstanding. Here MRC and the Department of Health have played a leading role in developing standards over the last 10 years, and while we find that UK academic culture and university funding systems sometimes undervalue such work, these areas of research have not developed more quickly in other countries. The issue is rather whether past policies on the role of public funding at the academic/industry interface have been over-cautious.

5.6 The Science and Innovation Strategy consultation paper also discusses the balance between investment in basic technology and basic science. Recent developments in generic research technology—such as PCR, monoclonal antibodies, confocal microscopy, micro-arrays, bioinformatics, and imaging—are currently driving the pace of progress in the biomedical research sector, and research technologies often find early application in clinical practice. The pattern of development is often different to that in other sectors, however. New technologies—such as monoclonal antibodies or confocal microscopy—often emerge from very basic, curiosity led research programmes, sometimes at first as a means to an end, rather than with the aim of developing a new technology. The time between concept and application can also be particularly short: the gap between MRC funding for Professor Southern's work that led to micro-array technology and its world-wide use in genome research was less than ten years. So while MRC provides substantial funding to research that is intended to develop new generic technologies, or does so serendipitously, there is often no firm divide between technology development and mainstream biomedical research.

5.7 Application of MRC research in the health service and other public services raises a different set of issues, which are equally important. In a small number of areas, new medical technologies are likely to be developed from initial concept through to clinical application almost entirely in the public and charitable sectors. This is likely to be the case for some gene therapy applications, immunotherapies, transplants, and vaccines. In these areas, there is a need to develop university infrastructure and research management skills, and clinical facilities to allow the effective management of the more complex R&D process, and to ensure safety. This need can best be met by focussed investment in a relatively small number of centres of excellence—MRC is already funding such developments, but further investment will be needed.

5.8 In most cases, however, the need is for knowledge transfer to inform health policies or medical practice. The Department of Health has led the way in developing the Cochrane Collaboration, NICE, and other bodies to assist the development of evidence-basic practice. There is still some scope for improvement, however. In particular, all of these activities depend on the time of university staff, MRC staff, and NHS staff, in assembling and assessing the scientific evidence, and the UK needs to ensure that university funding models, and academic career paths give sufficient incentives for public-sector knowledge transfer activities.

6. The Public's Relationship with Science

6.1 *Realising Our Potential* emphasised the value to the country as a whole of a more scientifically- and technologically-informed population, and encouraged new initiatives to complement the many schemes already in existence. Science teaching in schools was also recognised as critical, not only to the general science-literacy of society, but as the source of knowledge, inspiration, and careers information for future generations of researchers.

6.2 Since 1993, the commitment of most biomedical researchers to communicating their work to wider audiences has undoubtedly increased, as has the quality of their presentation. Most also recognise the need to go beyond communicating science, to engagement in dialogue about the potential impact of the application of their work on society, individuals and the environment.

6.3 Since 1993, the Medical Research Council has developed a strategy for communications with all of its various publics. The steps taken include:

— expanding MRC's press team to facilitate media coverage of MRC science, and to support scientists and doctors in presenting their work. This work spans the range from explaining complex issues of risk and interpretation of scientific data (such as in relation to the evidence of links between the MMR vaccine and autism or irritable bowel disease), to engendering interest in major new clinical trials and population studies, to explaining scientific breakthroughs and milestones;

— launching a Schools Programme (1993)—to provide teachers and pupils with compelling material (both written and electronic) on medical science;

— organising and/or sponsoring numerous events to inform and interest the wider public in science, including presentations and practical demonstrations in major "general interest" exhibitions, shopping malls, and railway stations;

— organising events to maintain the awareness of GPs and other health professionals of genetics and other fast-moving areas in medical research;

— developing programmes of communications training for scientists, covering general communications skills, skills for schools work on particular issues (eg the use of animals in research), and media skills.

6.4 However, in emphasising "public understanding of science" the White Paper overlooked the many other factors that contribute to the public's relationship with science and its applications. To create a relationship of trust, scientists and policy makers alike need to understand the public and their attitudes and worries, and to be seen to listen and learn. Over the last few years the Medical Research Council has been giving a higher priority to work that improves our understanding of the public's views, and to work that creates dialogue and engagement around real issues, which in turn helps people to understand the context in which scientific information is used.

For example:

— we have formed a Consumer Liaison Panel to help us improve consumer input into MRC's business;

— as part of the planning for a large scale collection of donated DNA samples, we have been listening to the public's attitudes, questions and concerns in focus groups, and are now planning the next stage, a more focused consultation on the specifics of how the collection should be run. We have already completed a consultation—mainly with specialists and public interest groups—on the general ethical principles that should apply;

— in 1999, we commissioned MORI to undertake an in-depth study of public attitudes to the use of animals in research, encompassing their level of knowledge, trust in existing regulations, values, and reasoning, and published the results;

— we are organising a series of briefings for opinion formers on topic issues, such as stem cells, cloning, and animal experimentation.

The recent report of the House of Lord's Science and Technology Committee, Science and Society (February 2000), provided a timely and welcome call for greater emphasis on dialogue, and a move a way from the 1993 models of "public understanding of science". We hope this thinking would be reflected in the proposed White Paper.

6.5 Science and Society also held that although most UK scientists are now more committed to communication than in 1993, there is still a need to promote more and higher quality work by individuals and by universities. We agree that there is a need to continue improving skills, and encouraging commitment of resources, especially as dialogue is inevitably more time consuming and challenging than straightforward explanation of science. It is also important to emphasise the value of local activities based around a particular town, interest group, or network—as *Realising Our Potential* stated "Successful promotion of the public understanding of science and technology is most likely to be achieved by organisations and individual scientists and engineers passing on their knowledge and enthusiasms within their local communities". These links can be particularly valuable in that they avoid some of the artificiality of attempts to create dialogue and trust on a national scale. MRC is continuing to facilitate local links, and is well placed to do so by building on its Units and Institutes across the country. We are also looking at ways of encouraging universities to strengthen their communications work in these areas.

6.6 The consultation paper on Science and Innovation Strategy emphasises the role of transparency in improving public confidence. In our experience it is essential for the scientific reasoning behind advice to the public, and for information about the individuals and processes involved in formulating the advice, to be made available.

6.7 But we have to be aware that information may raise, rather than quell, anxieties, especially at first. When new information about, for example health and environmental risks, emerges, it is difficult to put in context, and there are always those who have an interest in sensationalising the "new revelations". The objective has to be to develop a tradition of more informed debate over many years, not to seek quick solutions.

6.8 Also, while secrecy and bias are definitely news, openness and good decision-making are not. What the public are not aware of will have no impact on their confidence in science and innovation. For example, in the study they conducted for us, MORI found that there was very little awareness that the UK had a robust, centralised, regulatory system controlling the use of animals. With that starting point, important features of the system such as the involvement of animal welfarists in the Animal Procedures Committee, or the wealth of information and statistics available to those who know where to look, must have little impact. Experience also shows that exercises in public dialogue, such as citizen's juries or consensus conferences on topics like transgenic plants of xenotransplantation, are seldom mentioned when these issues are covered in the media. Transparency, therefore, has to be an active process. To build confidence, the processes governing science and scientific policy making have to be energetically publicised, explained and defended by Government and by scientific organisations.

6.9 Finally, there also have to be some limits to openness. For example, in areas of high public interest close to policy-making, such as TSEs research, the clamour for immediate public disclosure of undigested scientific results needs to be kept in check.

7. International Science

7.1 The UK has, on the whole, made good progress towards the goals set out in the White Paper for EU funding (6.8–6.11). The key themes in the Commission's Fifth Framework Programme reflect broad UK research strategies—for example, in the emphasis on post-genome approaches, and ageing research—and MRC played a key role, together with the Department of Health, in developing the biomedical aspects of the "Quality of Life.." programme in Framework V.

7.2 MRC, and the other UK Research Councils, also have a crucial role to play in ensuring that Framework VI meets UK science needs in the European context. It will be important to continue the close consultation and co-operation—facilitated by OST—between government departments and Research Councils, that has characterised the UK negotiations for previous Framework Programmes.

Developing Countries

7.3 The 1993 White Paper "Realising Our Potential" focused very much on international research collaboration as a means of improving UK economic output, but did not discuss the role of research in international development—both in delivering new solutions to health problems, informing policies, and developing countries own research capacity. MRC has a very effective concordat with DFID (formerly ODA), which includes the provision for the transfer of some funds from DFID to MRC to enable us to address shared strategic priorities in Developing Societies. Areas of common interest include:

- a major AIDS research programme in Uganda, which celebrated its tenth anniversary in 1999. This has had a major impact in controlling the epidemic in this country, whilst also providing unique insights into the clinical pathogenesis of AIDS following HIV infection. A new programme on AIDS vaccines in Kenya is also about to be launched.
- a "contraceptive development network", linking the MRC Human Reproductive Sciences Unit in Edinburgh with nodes in China, Hong Kong, S. Africa and Nigeria. This network for clinical studies is specifically designed to overcome the development gap between basic research and the pharmaceutical industry, in a very sensitive but critically important area.
- a substantial research programme in The Gambia, which celebrated its 50th anniversary recently. This programme is focused on important infectious disease such as malaria and TB, but is also now expanding into research on non-infectious diseases, such as diabetes. The burden of these diseases in developing societies is now increasing dramatically.

7.4 What each of these strategic programmes have in common is that they exploit unique clinical research opportunities that do not exist in the UK, whilst addressing crucial global health issues, which are of particular importance to the host countries. To co-ordinate these activities and explore further opportunities for strategic overseas investment, a new MRC Advisory Committee on Overseas Research has recently been established. We have also set-up a panel to advise Council on the important ethical aspects of this research and MRC is an active participant and sponsor of the Global Forum on Bioethics in Research.

Exchanges, co-operation, and collaboration

7.5 Science is a global venture, and as discussed earlier the UK must actively look abroad for new talent and ideas if it is to maintain its excellence. Apart from MRC's specific initiative to promote recruitment from abroad, all MRC Units and Institutes have extensive international collaborations, and the international visibility of flagship institutes such s the Laboratory for Molecular Biology and National Institute for Medical Research allows them to act as a focus for collaborations and exchanges. With the exception of PhD studentships, all MRC training and career development awards are open to non-UK applicants and our grant support schemes allow for recruitment from overseas.

7.6 While most scientists in the UK need little incentive to form collaborations with colleagues based in other countries, MRC has a strategic role in ensuring that mechanisms are in place to promote international collaboration, and in exploring opportunities that might further UK interests. We are responsible for the UK subscriptions to two major international funding agencies—HFSP and EMBC/EMBO/EMBL, both of which we are currently reviewing with regard to their value to UK science. We are also constantly considering whether strategic alliances can help strengthen UK science in particular priority areas. We have recently agreed with CNRS, France, to establish joint programmes in the UK, and have established a joint committee with France and Germany to consider use of DNA microarray technologies in Europe, an area where a concerted international approach offers scientific benefits and cost savings.

June 2000

APPENDIX 30

Memorandum submitted by the Natural Environment Research Council (NERC)

Introduction

1. The Natural Environment Research Council (NERC) welcomes this opportunity to provide evidence into the Committee's inquiry: *Are we realising our potential?*

2. NERC is the UK's leading organisation for basic, strategic and applied research and training across the spectrum of the environmental sciences. NERC's purpose is to support high quality scientific research, survey, monitoring and postgraduate training with the objective of enhancing knowledge, understanding and prediction of the environment and its resources. NERC achieves this through its support of scientists at universities and through its own Centres and Surveys: the British Antarctic Survey (BAS), the Centre for Coastal and Marine Sciences (CCMS), the Centre for Ecology and Hydrology (CEH) and the Southampton Oceanography Centre (SOC—a joint venture with the University of Southampton).

3. This memorandum includes input from NERC Council members, CEH and BGS.

4. NERC's current structure and operations have been very much influenced by the 1993 White Paper: *Realising our Potential* and its impact is still in evidence today. The three major themes of *Realising our Potential* are: scientific excellence to underpin wealth creation and quality of life; partnership; and exploitation of science. NERC's three main objectives outlined in our 1999 Strategic Plan build on these:

- to enhance the excellence of the Science Base;
- to focus NERC science on priority issues;
- to put NERC science to work.

5. *Realising our Potential* emphasised the importance of creating partnerships to benefit UK wealth creation and quality of life. It promoted a change in culture within the science community, increasing collaboration, dialogue and instigating the formation of partnerships. However, the initiatives that resulted from *Realising our Potential* tended to centre on wealth creation themes. Whereas this is perfectly acceptable the important contributions that research can make to the public good should not be forgotten.

6. Our evidence is structured around the questions posed by the Select Committee:

- the extent to which the measures and objectives outlined in the White Paper have been successfully delivered;
- their impact on the management and performance of science and technology; and
- whether the structures it specified are still appropriate.

WHITE PAPER MEASURES

Forward Look

7. Since *Realising our Potential* we note that the annual Forward Look has become more focused and concise, targeted at a wider readership. It sets out science priorities and provides an analysis of expenditure. However, we have received little feedback from readers on NERC's input to the Forward Look.

Technology Foresight/Foresight

8. The initial round of the Foresight process was extremely valuable to NERC. It achieved its aims, which were to facilitate collaboration, forge useful relationships between different stakeholders and help place science in a broader context. NERC was fully engaged in the process; the Foresight Panels' findings contributed to NERC strategy and led to new initiatives such as TSUNAMI, a partnership between scientists and the insurance industry. Foresight enabled the identification of national priorities.

9. NERC has been involved in the Foresight 2000 consultation exercise and has produced a formal response. The present round of Foresight, which is still under development, is likely to be as, if not more, productive than the first. Through Foresight we are building a consensus view between researchers and users on future needs, opportunities and threats. NERC's view is that Foresight 2000 should focus on a small number of high level long-term strategic issues of national and global importance. Through a number of initiatives, NERC is supporting moves to encourage Foresight Panels to address the overarching theme of sustainable development, although it is too early to assess the importance which Foresight Panels attach to this theme.

Council for Science and Technology (CST)

10. NERC has had no direct involvement with the Council for Science and Technology. The CST has been less open and transparent than NERC's advisory and decision making bodies, although we welcome the information that is now available on the CST website. There appears to be little connection between the business of the CST and the Science and Engineering Base Co-ordinating Committee (SEBCC).

Technology transfer/interchange initiatives

11. Strengthening links with industry is a key requirement of *Realising our Potential.* Since the White Paper the existing NERC grant schemes designed to increase collaboration with users have strengthened and new schemes introduced. Relevant current award schemes are listed in Annex 1. We have also increased the emphasis of our thematic programmes (which involve basic, strategic and applied science, within themes selected by Council), on user involvement and on enhancing the prospects for exploitation of results.

12. Another important mechanism for knowledge transfer is research commissioned by external organisations such as the European Commission, Industry and particularly government departments. In the period 1998–99 NERC's Centres and Surveys received £18.4 million external funding from the public sector. This compares less favourably with each of the previous three financial years where external funding from the public sector was around £23 million.

13. The 1998 Competitiveness White Paper: "*Our competitive Future: Building the Knowledge Driven Economy*", reiterated and reinforced the Government's commitment to the exploitation of research. It included a commitment to increase the commercial potential of the research outputs of Public Sector Research Establishments (PSREs). The Paper led to the 1998 Baker Report entitled "*Creating Knowledge, Creating Wealth—Realising the potential of PSREs*". The Government's response to this report made knowledge transfer an explicit mission of Research Councils and their Chief Executives. In addition it outlined a number of measures to "level the playing field" by opening up schemes such as University Challenge to provide seedcorn funds for new business ventures, removing a considerable barrier to exploitation. NERC welcomes the report and the Government's response, and looks forward to the implementation of the report's recommendations.

14. NERC continues to develop paths for increased knowledge transfer. We have recently launched a business plan competition to promote commercial exploitation of NERC funded research. The competition is open to all publicly funded scientists investigating the natural environment who wish to see their research developed into a commercial business proposition. NERC has also established an Exploitation Best Practice Network and an Innovation Fund to promote commercialisation of its science. NERC has established its first spin out company and expects more to follow.

Innovation support programmes for small and medium sized enterprises

15. The LINK initiative operated by the Office of Science and Technology (OST) offers a mechanism for collaboration between the public and private sectors in areas of strategic importance to the national economy as identified by Foresight. NERC is currently involved in six LINK schemes, including Earth Observation, Aquaculture and Seasense, all of which involve collaboration between NERC scientists and small or medium sized UK companies. This has been an extremely successful scheme.

16. NERC is also one of the 11 government bodies and Research Councils which provides grants for supporting the Teaching Company Schemes (TCS). TCS is dedicated to helping industry innovate through collaboration with research and education. The scheme supports partnerships between universities and companies for technology transfer and training. Typical aims include introducing new or improved products, services and processes; introducing or improving systems; and entering new markets or improving penetration of existing ones. Only a few of the programmes that NERC has been involved in have reached completion, but early indications are of projects successfully achieving their goals.

17. Many different schemes have been introduced since *Realising our Potential* and while most are working effectively, there are probably too many schemes and the research community understandably finds this landscape confusing and difficult to navigate. The Government should bear this in mind when considering the context of any new science strategy.

Public understanding of science

18. *Realising our Potential* raised the issue of the need for greater efforts to improve public understanding of science and technology. It added to NERC's mission the responsibility to provide advice, disseminate knowledge and promote public understanding of science.

19. In response to the White Paper, NERC re-organised its staff working on public relations, publications and public understanding of science into a single group and identified target audiences. Today we are involved in a wide range of activities aimed at communicating our science to wide audiences. Examples include plays and conferences for school children, talks and displays for adults, a range of publications on key environmental issues, a consensus conference on radioactive waste disposal, and briefings for opinion-formers and decision-makers, such as Parliamentarians.

20. A number of specific initiatives to promote science, technology and engineering were suggested within *Realising our Potential*. These included: the Creativity in Science and Technology Award Scheme (CREST); careers initiatives; communication training; and a high profile National Science Exhibition to be held in 2001. NERC has been involved in CREST as a sponsor of the Environment Research Challenge and has found it to be an excellent way of raising the profile of environmental science within schools. We also produce a careers leaflet and organise courses in science communication skills for our researchers; feedback from participants has been excellent.

21. Despite the achievements of *Realising our Potential*, events in the news recently, such as BSE and GM crops, have led to a crisis of confidence in science and scientific advice. The recent House of Lords Select Committee on Science and Technology Third Report; *Science and Society* identified shortcomings in the current relationship between scientists and the public. The report contained five major messages:

(i) there is a crisis of public trust in scientific advice to government;

(ii) public values and attitudes must be heeded;

(iii) a new culture of dialogue is needed between scientists and the public;

(iv) there must be a presumption of openness and transparency;

(v) scientists must learn to live with a free press.

NERC accepts the five main messages of the report. Despite the progress that has been made since 1993, the growing public profile of science demands new approaches. NERC intends to strengthen its own policy and actions in science communication, in particular to promote dialogue between science and society. NERC Council is currently reviewing NERC's activities in these areas.

22. We have already made significant progress toward greater openness including:

- posting agendas and a record of decisions made at Council on our website;
- holding (jointly with BBSRC) a web-based consultation on research into gene flow in plants and micro-organisms;
- providing the UTLS-OZONE Thematic Programme Expert Panel as a web-based service to the community;
- making the NERC Operating Plan update and the NERC Operating Report public; and
- appointing a full-time press officer to increase proactive communication of science achievements and NERC business.

Wealth creation and quality of life

23. While NERC welcomes the influence of *Realising our Potential* in focusing on the impact of science on wealth creation and quality of life, an imbalance has developed in the emphasis. In particular insufficient emphasis has been placed on the exploitation of science for public good. In addition to funding excellent science, NERC plays a significant role in supplying policy advice to government and plays an important role in communicating science to the public. Both of these roles can contribute, directly or indirectly, to quality of life.

MANAGEMENT AND PERFORMANCE OF SCIENCE AND TECHNOLOGY

The reorganisation of the Research Councils

24. *Realising our Potential* has provided the impetus to analyse operations and improve efficiency within the Research Councils, allowing a greater proportion of the Science Budget to be freed to fund science. Much has been achieved since 1993 through rationalisation, restructuring and funding more efficient ways of working, often through joint initiatives.

25. Since *Realising our Potential* NERC has made a number of changes aimed at increasing efficiency and effectiveness:

- streamlining of the Council;
- restructuring of NERC Institutes and laboratories to form five Centres and Surveys;
- the introduction of the NERC funding model to open up competition and develop a level playing field between universities, Centres/Surveys and other sections of the scientific community;
- a greater emphasis on the exploitation of research and the need to work in partnership with the user community to maximise the benefits of NERC science to the UK; and
- publication of an integrated science strategy that outlines key challenges over a five to ten year period.

26. Over the last five years NERC's share of the Science Budget spent on central administration has decreased from 5 per cent to 4 per cent. We believe that to further reduce our administration costs would result in a transfer of functions and costs to scientists in universities and Research Council Institutes. Increasingly the Research Councils are asked to administer new schemes (eg JIF) without additional resources being made available and at a time when we are under pressure to reduce further our administrative costs.

27. NERC is in regular discussion with the other Research Councils about ways in which collaboration can be increased further to improve efficiency and strengthen working relationships. We are constantly reviewing practices to ensure no money is wasted. Payroll, purchasing and IT support at Swindon Office are all being scrutinised for further savings. NERC is now using the Particle Physics and Astronomy Research Council (PPARC) system to deliver research grants and is evaluating the implementation of a single grants administration system, to determine if further cost savings can be made.

28. There has been a growing number of joint research programmes using a multi-disciplinary approach to tackle complex scientific issues. An excellent example of such collaboration is the Tyndall Centre for Climate Change. This new national £10 million centre has been delivered following the last comprehensive spending review. Jointly funded by NERC, the Engineering and Physical Sciences Research Council (EPSRC), the Economic and Social Research Council (ESRC) and the Department of Trade and Industry (DTI), the centre will undertake research to seek the views of the public, brief politicians and the media, and engage industry through its business liaison programme.

29. The 1995 "Prior Options" reviews concluded that CEH, CCMS and BGS were performing necessary functions and should not be transferred from the public sector. NERC and its Centres and Surveys are about to be subjected to further scrutiny in the shape of the Government's Quinquennial Reviews (QR) and Better Quality Services reviews (BQS). Whilst NERC recognises the importance of reviewing its operations and structures, there is a danger of over-review. Working with OST, we plan to avoid review duplication by bringing together our own review mechanisms with those of government, notably, QRs and BQSs.

5. A significant development since *Realising our Potential* has been Devolution. The full impact of this shift still remains unclear. NERC will continue its discussions on issues of shared interest with the Scottish Executive, Welsh Assembly and Northern Ireland Assembly.

The creation of the post of the Director General of the Research Councils

31. The new Director General of the Research Councils (DGRC) was charged "to ensure that the Councils work together to achieve a common approach and take advantage of the possibilities for improved efficiency through joint working". The creation of this post has increased both collaborative working (in the form of joint programmes and studentships) and competition (for example when bidding for extra funding, between the Research Councils).

32. The DGRC advises ministers on: the resources needed for the Science Base; on the detail of the case to be made; and, subsequently, on the allocations to the seven Research Councils, the Royal Society and the Royal Academy of Engineering. The impact of the DGRC's post can, in part, be measured by the successful outcome of the 1997 Comprehensive Spending Review. The move towards a three-year funding profile has enabled NERC to plan its investments in science over the longer term.

33. In 1997 the House of Commons Parliamentary Select Committee on Science and Technology investigated the operation of the Research Councils' system and the role of the DGRC in relation to scientific advice. It concluded:

> "There may be temptation for government to reconsider the system for managing, reviewing and allocating funds for public research; the evidence we have received leads us to believe that the present system is working well and there is accordingly no requirement for major change, with all the disruption that it would bring."

We welcome this clear endorsement of the role of the Research Councils and DGRC.

The absorption of the functions of the Advisory Board for the Research Councils into the Office of Science and Technology

34. NERC has close working links with the OST. There is contact between officials on a daily basis. A senior OST official attends NERC Council meetings and there are regular meetings of Research Council Chief Executives chaired by the DGRC.

35. One of the reforms listed in *Realising our Potential* was a commitment to maintain and strengthen the Rothschild customer-contractor principle in relation to departmental applied research and development. The House of Commons Science and Technology Select Committee's Fifth Report: *Government Expenditure on Research and Development: The Forward Look* (March 2000) identified the issue of departments withdrawing funding from the Science Base, often at short notice. Where this affects Research Council Institutes this may result in staff redundancies, site closures and, at worst, loss of national research capability in particular areas. The financial consequences are frequently borne by the Science Budget. For example when DTI reduced its contract with BGS in 1996, without forward advice, several BGS employees had to be made redundant. More than half the cost had to be found from within the NERC Science Budget.

36. *Realising our Potential* encouraged the development of concordats between NERC and cognate government departments. Such agreements provide only a framework; real co-operation depends on the mechanisms and working relationships between the staff involved.

37. NERC is committed to the Haldane principle of an arms length relationship between government and the decision-making processes of the Research Councils. We acknowledge that some funding occasionally needs to be held by OST to support major cross council initiatives, but we would not expect this to be a rising trend. There is significant evidence of Research Councils already managing and supporting cross-council initiatives.

Appropriateness of Structures

38. The emphasis of *Realising our Potential,* creating partnerships to benefit UK wealth creation and quality of life, is as relevant now as it was in 1993. Its greatest impact has been to promote a change in culture within the science community, encouraging greater dialogue, partnership and collaboration.

39. One of the impacts of *Realising our Potential* for the Research Councils has been new activities such as liaison under the User Community, familiarisation with Intellectual Property Rights issues, exploitation mechanisms and commercialisation issues. Not only does the expansion of activities, without explicit additional resources, require new management skills but it also exposes Research Councils to the new commercial risks and may alter the public's perception of our independence and impartiality.

40. The Research Councils, including NERC, are heavily reliant on the UK Higher Education Institutions (HEIs) for delivery of government research policies and objectives. Whilst the HEI sector has demonstrated innovation in respect to responding to new challenges such as the Research Masters initiative (MRes), this was primarily an additional income stream rather than a new approach to postgraduate education and training. Increased co-ordination of the delivery of research objectives at governmental level is required. The only opportunity for these two elements to come together is via SEBCC, which has been a useful forum for information flow and exchange but has delivered little agreement or policy.

Strategy for science engineering and technology

41. NERC published its first integrated science strategy *Looking Forward* in May 1998. This, together with seven more detailed sectoral strategies, is available on NERC's website www.nerc.ac.uk.

June 2000

Annex 1

CURRENT FUNDING INITIATIVES DESIGNED TO FACILITATE LINKS BETWEEN RESEARCHERS AND USERS

Mechanisms	*Description*	*NERC involvement*
CONNECT	Initiates new interactions between the Science Base (universities, NERC Centre/Surveys and NERC approved academic analogues) and industry, business, commerce or public sector bodies.	In 1998–99 NERC was involved in 7 connect schemes.
Industrial CASE	This studentship scheme aims to provide UK-based industry, business or commerce with the opportunity to formulate and submit a three-year PhD research studentship application.	In 1998–99 NERC was involved in 16 industrial CASE schemes.
LINK	This initiative is operated by OST and offers a mechanism for collaboration between the public and private sectors in areas of strategic importance to the national economy as identified by Foresight.	NERC is currently involved in 6 LINK schemes, including Earth Observation, Aquaculture and Ocean Margins.
ROPA (Realising our Potential Awards)	Provides opportunity for curiosity-motivated research to applicants who already have a record of securing funds for generic research from bona fide industry, business or commerce.	In 1998–99 NERC was involved in 11 ROPA schemes.
JREI (Joint Research Equipment Initiative)	Researchers are able to apply for equipment grants on the condition that matching funds from an industrial collaborator are available and that the proposals are in line with Foresight.	In 1998–99 NERC was involved in 11 JREI schemes.
TCS (Teaching Company Schemes)	TCS supports partnerships between universities and companies for technology transfer and training.	In 1998–99 NERC was involved in 8 TCS schemes.
Concordats with government departments	Formal agreements between NERC and government departments providing a framework for promoting effective interaction and developing collaboration.	NERC has signed Concordats with 6 Government Departments/Agencies, and has Memorandums of Understanding with 2 others.
Agreements with local government	NERC seeks to involve relevant stakeholders such as local authorities in its programmes.	Eg Local Authority Research Council Initiative (LARCI). This initiative aimed at improving communication channels between the science base/research councils and local authorities. The initiative involved BBSRC, EPSRC, ESRC, NERC and MRC. It focused on areas such as the management and remediation of brownfield sites and contaminated land.
Links with industry and government	Initiatives which involve stakeholders from government, Industry and the Research community.	Eg Contaminated Land: Applications in Real Environment (CLAIRE) a public/private partnership involving stakeholders from government policy makers; regulators; industry; research organisations; technology developers. CLAIRE's mission is to catalyse the development of cost-effective methods of investigating and remediating contaminated land in a sustainable way.
Cross Research Council	Joint research initiatives with other Research Councils.	NERC is involved in a number of cross research Council initiative eg the Tyndall Centre for Climate Change Research (ESRC, BBSRC), the gene flow programme (BBSRC), the Initiative in Environment and Health (MRC).

Mechanisms	*Description*	*NERC involvement*
Spin out companies	Companies created as a result of opportunities created by NERC funded research.	An example of successful commercialisation of academic research is *Evolutec,* a Company developing a number of promising new drugs for treating diseases such as asthma, allergy and rheumatoid arthritis.
Other ad-hoc links	NERC is continually seeking new ways to increase partnerships and enhance knowledge transfer and use of data arising from NERC research to increase exploitation of NERC science and other mechanisms.	Eg The TSUNAMI initiative aims to improve the competitiveness of the UK insurance industry by using the UK science effort to improve the assessment of risk. It is jointly funded by the Insurance Division of the Treasury and a consortium of composite insurers, brokers and Lloyd's managing agencies. Government support is from the Sector Challenge of the Department of Trade and Industry.

APPENDIX 31

Memorandum submitted by Mr A Bhogal, Director Engineering and Deputy Secretary, the Institution of Civil Engineers

The Institution welcomes measures that promote the importance of science, engineering and technology in the world today. We have no specific comments to make; however we would like to make the following points with regard to the positive influence the White Paper has had on the Research Councils. In particular:

(1) there has been a shift towards funding research proposals that can demonstrate wealth creation or improvement in the quality of life as an outcome;

(2) changes to the management of the Councils, in particular the EPSRC, and the way in which it promotes itself have resulted in much better communication with the academic community, leading to more relevant grant proposals;

(3) the projects funded under the Public Understanding of Science initiative are all extremely relevant and in the long term will lead to better public appreciation of the significance of scientific research to society.

15 June 2000

APPENDIX 32

Memorandum submitted by Bolton Institute

INTRODUCTION

1. Bolton Institute is a higher educational institution comprising three Faculties:

(i) The Faculty of Arts, Sciences and Education;

(ii) The Faculty of Business; and

(iii) The Faculty of Technology.

2. Within two of these Faculties about 3,000 students study on courses leading to HND, BSc and MSc awards across the scientific and technological disciplines:

- automotive engineering;
- biological and environmental studies;
- civil and environmental engineering;
- construction;
- electronic and computer technology;
- design and mechanical technology;
- psychology; and
- textile technology.

In addition, research teams work in each of these areas with over 70 research students registered for higher research degrees.

3. The evidence submitted in this memorandum relates only to those changes and initiatives arising from the White Paper that have impacted significantly upon the Institute and its development since 1993. As outlined below, this impact has been considerable in certain areas outlined.

TECHNOLOGY FORESIGHT

4. The value of the creation of Technology Foresight has been recognised at various levels from involving selected (invited) staff to participate in the process to enabling the Institute to focus its science and technological activities in a more strategic fashion.

5. With regard to the latter, the Institute has always offered courses vocationally orientated to key regional wealth-creating sectors. It has generated consultancy and commercial activities in parallel with its curricular and research activities. By choice, research has always been of an applied character in order to address applied problems and Foresight has aided this focus.

6. The Foresight process and its prioritised agendas have enabled Institute academic staff to prioritise activities and to map these on to those of research and project initiative funders more effectively. For example, the clear statements within the Foresight Materials agenda have enabled the Institute to develop an UK presence in technical textiles research and gain related research funding from EPSRC and DTI in collaboration with industry and universities.

7. In addition, the Institute has taken a lead in the Foresight process for the UK textiles sector and this initiative has drawn together all relevant HEIs from across the UK as well as industrial representation.

EMPHASIS ON TECHNOLOGY TRANSFER

8. Not unrelated to the above outcomes has been the development of technology transfer as a prime activity within the Faculty of Technology. Currently, technical expert advice and transfer are undertaken in each of the technological areas identified in paragraph 1 above.

9. Of particular note, is the significant expansion in microelectronics where Bolton Institute has been the DTI-designated North West centre for microelectronics in business since 1990. This DTI-supported technological transfer to the region's microelectronic engineering companies has been supplemented by EU funding under the FUSE programme. The Institute is recognised by the European funders as one of only a few "model" technology transfer modes within the Community.

SMALL AND MEDIUM-SIZED BUSINESSES

10. The White Paper's focus on the need to improve access to SMEs has offered considerable opportunities for the Institute since 1993. Not only has it enabled the Institute's research and technology transfer activities to be focused upon this sector but also it has catalysed the development of SME-specific courses.

11. The MBA for Small Business was pioneered by the Faculty of Business during 1996 and is now providing a supply of highly trained managers for the SME sector.

12. Using an EPSRC IGDS (Integrated Graduate Development Scheme) award in 1996, the Faculty of Technology has developed and implemented the UK's first MSc in Advanced Microelectronics for Industry to be offered over the Internet and delivered to the workplace.

13. The Institute has more recently won funding from European (eg "The Virtual Centre", ADAPT programme to develop on-line management learning to extend the MBA in Small Business to the Internet) and regional development agency sources to develop skills and training packages with special focus on SMEs across the North West.

14. Based on its success in the above activities and its commitment to supporting the SME sector, the Institute has just appointed a Chair in SME Innovation within the Faculty of Business.

RESEARCH COUNCIL REORGANISATION

15. The Research Councils' commitment to wealth creation and the quality of life and their acknowledgement of the relevance of Foresight have enabled the Institute's new knowledge-based activities to map more closely on to these changed strategies. As a consequence, the winning of EPSRC and ESRC funding has increased significantly since 1993, with the majority of projects being in collaboration with external partners from the wealth-creating sectors.

16. The development of LINK along the lines of the White Paper proposals has enabled the Institute to participate in one successful Surface Engineering LINK programme (1996–99) and recently to be awarded a Foresight LINK project commencing in June 2000.

PUBLIC UNDERSTANDING OF SCIENCE

17. The Government's recognition of the importance of this has enabled the Institute to extend its activities into the public domain and to invite public participation in achieving elements of its mission.

18. More specifically, both formal and informal links have been forged with schools and colleges and these activities assist with the marketing of technologically-based courses and hence the recruitment of talented young people on to these.

SUMMARY

19. The White Paper has had significant impact upon the work and development of a medium-sized HEI with a significant science and technology portfolio of activities like Bolton Institute. Of prime importance is the paper's recognition of the need for relevance of the science and technology base and especially the role of technology transfer to SMEs. The Institute has benefited from and exploited these issues with success.

20. Further consequences of the White Paper have been to enable the Institute to be recognised for its position as a major science and technology provider in the North West region and for it to compete successfully with its larger University—titled neighbours.

21. The Institute's commitment to new knowledge creation and application (including via technology transfer) is at the core of its recently published Strategic Plan, 1999–2005.

9 June 2000

APPENDIX 33

Memorandum submitted by Dr Tadataka Yamada, MD, Research and Development, SmithKline Beecham Pharmaceuticals

INTRODUCTION

The past decade has seen a profound shift in UK science policy, driven by scientific, technological, economic, political and societal factors. The start of the transformation can be traced back to the decision to transfer responsibility for science from the Department of Education and Science to the new Office of Science and Technology, and to publication of the Science White Paper in 1993. This document, *Realising our Potential,* has been highly influential in setting out the priorities for publicly-funded research, in providing a new framework for the Research Councils, in identifying the likely determinants of competitiveness and in introducing the Technology Foresight Programme.

SmithKline Beecham welcomed the policy initiatives and we have committed ourselves to playing our part in addressing the challenges. Hard choices must still be made in reconciling infinite demand with finite resources in education, research and health care. We share the enthusiasm for coherence and consistency in policy, to capitalise on current opportunities so as to maintain the rank of the UK among the leading scientific nations and to educate a new generation for a world shaped increasingly by accelerating pace of technological change, but we have concerns as outlined in this paper.

The issues that need to be addressed continue to resonate globally. How large a scientific enterprise do we need? How do we set priorities? How do we measure success? How can we strengthen government-industry-university partnerships? How do we engage the public-at-large?

The pharmaceutical sector is a UK success story based on innovation and sustained R&D investment. The science base contributions to that success were discussed in detail at the Science and Technology Committee's Inquiry on the proposed merger between SmithKline Beecham and GlaxoWellcome. In brief, the science base is important to SmithKline Beecham in three principal areas:

- provision of well-trained researchers;
- access to knowledge that underpins our understanding of disease and the technologies that help to develop innovative medicines;
- support for lifelong learning to update our skills.

SmithKline Beecham has created an internal culture of lifelong development of knowledge and skills, and we do not act as a passive customer for the outputs from the education system. We make a major contribution to student training—supplying industrial experience though Sandwich (undergraduate) and CASE Award (PhD) programmes and vacation work projects and we also support a wide range of research collaborations, joint academic appointments and endowments.

There is room for optimism in seeing science policy recently move nearer to the heart of decision-making and political action. But, much more can be done to build coherence in policy for bioscience research across the full spectrum of education and training, technology transfer and fiscal and regulatory frameworks, as well as to reverse the decline in laboratory infrastructure in universities and create state-of-the-art science teaching and computational resources in schools. The 1993 White Paper provided a major impetus for change; capitalising on the extra funding and the mandate for change charted by recent government initiatives, requires not only selectivity and focus but also pluralism and partnership, and an understanding of what the many users of research want. The UK has achieved much in developing dialogue and partnership between government, academia, industry and other research funders (such as Medical Research Charities). In aggregate this is a singular research resource. In looking to future strategy developments we see some important opportunities and challenges in building on this partnership. In particular, we need to develop new forms of research infrastructure (for example, in health informatics), to identify best practice to facilitate technology transfer, to work towards informed public debate on contentious issues, to create an integrated strategy across government to promote innovation and avoid the silo budget mentality. In the rest of this paper, we elaborate on these priorities in the context of reviewing how the 1993 White Paper has been important.

Forward Look

We agree with the recent conclusion made in the Forward Look inquiry by the Science and Technology Committee—the Forward Look should resume its annual publication to provide a clear and updated strategy for Science, Engineering and Technology. The Forward Look report represents a critical resource for auditing progress in pursuit of the key objectives in science policy across government. For example, the decline in civil departments' R&D investment, highlighted recently by the Science and Technology Committee, is a cause for continuing concern and must be monitored closely, even though there is much to welcome in the renewed funding of other elements of the science base (for example, the Joint Infrastructure Fund).

We support many of the other recent recommendations from the Science and Technology Committee's inquiry on the Forward Look. We agree that:

- the Forward Look should seek to match expenditure figures more specifically to policy objectives and the achievement of departmental science strategies;
- national competitiveness should be added as an objective for science expenditure, complementing the objectives on wealth creation and improved quality of life;
- the co-ordination role of the Office of Science and Technology and the Chief Scientific Adviser should be enhanced, with a more explicit remit to intervene, where necessary, with departments;
- the Chief Scientific Adviser may require additional support to carry out his transdepartmental co-ordination role effectively;
- the role of the Ministerial Science Group should be clarified and expanded to oversee the Office of Science and Technology in its co-ordination role and to act as a forum for resolving disagreements.

Other key recommendations from the Science and Technology Committee Forward Look inquiry are addressed further in the following sections.

Foresight

We enthusiastically supported the creation of the Technology Foresight initiative, designed to achieve a culture change by better communication, interaction and mutual understanding between the scientific community, industry and government departments. We have long employed foresight techniques in our own R&D; as an active participant in the national Technology Foresight programme, SmithKline Beecham shared its experience of forward thinking on markets and technologies and gained access to new partnerships with academic and other research groups. For example, through the Technology Foresight programme, SmithKline Beecham came together with the British Heart Foundation, the Wolfson Foundation and Addenbrookes NHS Trust in a major consortium to pursue fundamental research for chronic degenerative diseases associated with ageing.

We have remained enthusiastic and active participants in the second round of Foresight but we raised a number of points at the consultation stage and these issues are not yet entirely resolved:

- the choice of cross-sectoral themes, such as "Ageing Population" is an attractive way forward to build wider public interest and to catalyse dialogue for the longer-term. But, in creating this new layer of aggregation, and as the objectives broaden, it is ever more necessary to ensure the alignment of Foresight activity with other strategic initiatives and current programmes rather than positioning Foresight as an isolated initiative in innovation. Our doubts remain that various government initiatives involving the Department of Trade and Industry (eg Foresight, Genome Valley, Biotechnology Clusters, Pharmaceutical Industry Competitiveness Task Force) are completely integrated;

- there was a general perception that government departments did not (and do not) see themselves as part of the principal audience for Foresight, particularly with regard to analysis of issues and delivery of implementation plans. There is still little evidence of developing coherence in science and innovation policy across Whitehall in consequence of the Foresight programmes. This is not just a matter of exporting Foresight priorities from the Office of Science and Technology to other departments but, also, using Foresight-like processes to inform policy development everywhere;
- the increasing enthusiasm to embrace those businesses not currently actively involved in R&D must be interpreted cautiously if it is not to become the pursuit of lame ducks and sunset industries. The Small and Medium enterprises (SME) sector is not homogenous and should not receive excessive attention since SMEs do not automatically represent the most important vehicle for new employment and wealth creation;
- lessons learnt from foreign Foresight exercises showed that most fail at the implementation stage. Scepticism about the value of Foresight will remain if there is not persuasive evidence of beneficial impact and this is a challenging goal because many of the process benefits (building networks) may be intangible. Foresight exercises are effective in identifying the opportunities and problems but Foresight initiatives must also galvanise the efforts to arrive at the solutions to problems. To reiterate—in addition to better linking with budget prioritisation and informed policy generation, Foresight has the potential to be a central feature in coherent government strategy for science and innovation and in the development of a supportive community-at-large. But, frankly, these objectives for cultural change have not yet been met;
- while many in R&D-intensive industry remain enthusiastic about the Foresight concept, it is critical that the exercise is properly resourced by the Office of Science and Technology. There is current evidence of rather variable support across the Panels with insufficient funding overall. Without greater government commitment, Foresight will not realise its potential.

ADVISING ON RESEARCH PRIORITIES FOR COHERENT GOVERNMENT STRATEGY

We do not feel competent to judge on the wisdom of abolishing the Advisory Council on Science and Technology and its replacement with the Council for Science and Technology but we are not aware that consultation across the science base constituencies or transparency of decision-making has improved in consequence.

What is important in optimising the mechanisms for advisory bodies is that there is joined-up government thinking in science and innovation policy. Recent government initiatives have delivered significant progress in developing an innovation framework of policies and instruments and the commitment to major science-based activities such as Foresight remains critically important. But, for innovation and competitiveness in the biosciences-based sector, coherent advice and decision-making requires the advisory mechanisms to address several other vitally-important aspects:

- in ensuring that relevant regulations, whether emanating within the UK or at the European Union level, or at the regional planning level, are science-based to create an environment in which R&D can flourish;
- in ensuring a strong legal framework to protect Intellectual Property in order to reward innovation in an era of escalating R&D costs;
- in ensuring that the awareness of the value of research and innovation (measured in both social and economic terms) is appropriately encouraged in the community at large;
- in ensuring that government itself acts as an informed customer for innovation—for example, there is significant need for the NHS to develop the required receptivity to embrace innovative medical products and services and for government and industry to work in partnership to deliver cost-effective medicine. Medicines reduce overall health care costs because they are the most cost-effective interventions for disease, but this benefit (and, thus, the full benefit of innovative research) is impossible to realise in a UK environment based on health budgets that are compartmentalised by siloed cost centres.

INTERCHANGE OF IDEAS, SKILLS, KNOWLEDGE BETWEEN THE SCIENCE BASE AND INDUSTRY

The objective of improving this interchange is central to all the points that we make in this paper. UK competitiveness requires that the increased funding for university research and infrastructure is prioritised strategically in pursuit of excellence, that there is increasing institutional mission differentiation and that the commitment to better partnership for technology transfer is further progressed. We believe that fostering relationships with established innovative firms is at least as important—probably much more important—than stimulating spin-offs from university research. While UK linkages are better than in many other European countries, we can still do better, by understanding and sharing best practice, in facilitating the transfer of intellectual property from academia to industry in order to realise the practical applications of innovation. For example, how effective are science parks and the various incubator models? Should the UK emulate the US successful application of Small Business Innovation Grants? The 1993 White Paper was a good start in exploring new approaches to knowledge transfer but much more is now needed in terms of analysis and dissemination of the critical success factors.

We recommend that the assessment of science base activities for Higher Education Funding Council purposes will require a wider range of weighted criteria than used previously, covering not just publication record but relevance of quality research (aligned with Foresight), links with teaching, impact and value to customers of research (particularly industry). We ask that the current Funding Council Fundamental Review is rigorous in addressing the fundamental issues. In support of the goals of mission differentiation, pluralism and industry interaction, it is important to find new ways to encourage secondment between industry, academia (and government) so that perspectives and competencies are better shared. However, R&D-intensive industry does not ask that universities take on the primary role for applied research and development work—we look to the science base for the longer-term and "blue skies" perspective.

The recent third stream initiative, "Higher Education Reach Out to Business and the Community" fund is a welcome experiment that may merit increasing resources providing that this venture is strategically well-integrated with the networking framework of other university-industry links initiated by different government departments

The degree to which entrepreneurship can be taught is debatable but Higher Education Institutions do need to communicate enhanced awareness of business, management competencies, the innovation process and the opportunities for public support of innovation. A general understanding of the importance of patent protection in enabling innovation is also highly desirable but this does not mean that universities should be encouraged to hold and develop their own patents—this task is often better assigned to industry.

Since the 1993 White Paper, much has been written about the importance of improving the flow of skilled scientists to industry and we will not now repeat all the points agreed during the Committee's inquiry on the SmithKline Beecham-GlaxoWellcome proposed merger. We would like, however, to take this opportunity to emphasise two issues:

- by comparison with the US; the UK can do much more in building diversity in its workforce, stimulating creativity, by encouraging greater recruitment from outside the UK, from Europe and elsewhere. The UK should continue to take a lead in Europe in encouraging student and researcher mobility and, more generally, should take a less restrictive approach to work permits and visa arrangements;
- we are concerned at the flow of clinical researchers into industry and, in particular, we are worried that the proposed revalidation procedures being developed by the General Medical Council may have an, unintended, adverse effect upon the recruitment of highly-qualified physicians. If talented physicians become unwilling to join the pharmaceutical industry because they fear that it will be difficult to return to clinical practice, then companies would not be able to maintain their present, extensive clinical research base in the UK.

Access for SMEs to Innovation Support Programmes

It is generally agreed that government can and should do better to recognise and reward innovation, but there is a danger that innovation policy becomes preoccupied with the SME sector, confusing the objectives of innovation policy and employment policy.

Nonetheless, since the Science White Paper and in consequence of the series of Competitiveness White Papers, there has been significant progress on resolving management, regulatory and financing issues for SMEs and for commercialising university research. The European Business Environment Simplification Task Force comprehensively explored the barriers for innovative SMEs across Europe and their recommendations (on venture seed capital, tax rates, capital allowances, incentives for mentoring) provide a rational starting point for action.

But, many start-up companies are moribund because they lack a viable business plan. Rescuing this tail of mediocrity should not be a priority for government. It is vitally important that incentives to invest in innovation are as applicable to the established innovative companies as to the SMEs. Spin-out of technology and people from larger companies will become a major source of start-ups and large companies also help SMEs to flourish by acting as partner and customer. It is essential to understand, however, that large, successful, R&D-intensive companies have also created an internal environment of entrepreneurship—their creativity should not be judged only in terms of their relationships with SMEs. We are highly interested in the recent recommendation from the Science and Technology Committee (Forward Look Inquiry) that there is a strong case to be made for extending R&D tax credits to large companies and, moreover, to cover the costs of market research and product launch within the scope of tax credits.

Reorganisation of the Research Councils and Application of Science and Technology for Wealth Creation and Improved Quality of Life

The modification of the Research Councils in consequence of the White Paper recommendations has been broadly positive. We find that, in developing best practice, the Research Councils have been proactive in seeking industry's advice on research funding priorities and the mechanisms by which their funds are disbursed. There is still some variability in these respects between the Research Councils—the best should serve as a model, with regard not only to practice, but also to structure, and a commonality of approach between the Research Councils would improve their effectiveness.

The potentially greater co-ordination between Research Councils, exemplified, by the recent over-arching statement of their future instrumentation and technology needs (Long Term Technology Review) is greatly welcome. We applaud the recognition of the need to establish multidisciplinary programmes across the Research Councils, the alignment with the activities underway in Foresight and the enthusiasm to collaborate with industry. This over-arching, Long Term Technology Review is a highly-important development in taking forward the three key issues for the Research Councils: Quality, Interdisciplinarity, Partnership.

We wish to take this opportunity to emphasise two general concerns associated with taking forward these objectives:

1. The continuing difficulties in providing career progression for fixed-term contract research staff and in properly funding PhD students (by comparison with the higher stipends offered, for example, by The Wellcome Trust and Imperial Cancer Research Fund). We welcome recent Research Council proposals for greater flexibility in support for doctoral-level training; we believe the remedy is to reduce the number of studentships (and, perhaps, go to four year studentships) but increase the stipend. We also urge the Research Councils to continue to experiment with a range of funding models to ensure the subsequent encouragement of the younger, less-established researchers, early in their careers.
2. The continuing issues relating to the translation of basic into clinical research and the problems with training clinical researchers (as described in previous reports from the Rex Richards Inquiry and the Academy of Medical Sciences). These issues—vitally important in facilitating knowledge transfer—can also be addressed by building further partnership between the Research Councils industry, other medical research funders and the NHS. But, our worries on clinical research training compound our growing concerns on other aspects of the UK clinical R&D environment. For example, there are significant issues for pharmaceutical companies with respect to prolonged start-up times for clinical trials in NHS facilities, for the transparency and level of costs imposed (high overheads) and because fragmented capacity at NHS sites creates problems for achieving critical mass in patient recruitment. There are also unrealised opportunities. The NHS is a substantial but underused research resource—for example in population genetics and in health outcomes—and there is significant potential for building partnership by sharing data and analyses in order to deliver improved quality health care and to develop better clinical research training. Reinforcing the point made earlier, we need to establish the infrastructure to permit adequate capture of health care and health economic data in order to ascertain the impact of innovative therapeutic solutions to medical conditions.

Campaign to Spread Understanding of Science among School Children and the Public

The public is not an homogenous group. Scientists and policy-makers often err in their predilection for tailoring a desired message rather than engaging in scientifically-informed debate. It is easy for the community at large to feel underestimated and coerced. We agree that it is the responsibility of scientists, whether in academia, industry or public service, to do more to enunciate the benefits that can accrue from R&D. We support the many excellent recommendations from the recent House of Lords Science and Technology Committee Report on Science and Society, relating to the need for cultural change in favour of open and timely public debate with the Government giving a lead at European level in fostering public dialogue. As the recent Eurobarometer survey confirms, public attitudes toward research in Europe remain a significant problem. Furthermore, misguided attacks by opinion-leaders on genetic technologies and medical informatics (for example, in terms of exaggerated privacy concerns) increase public sensitivities and may severely restrict the R&D environment. We believe that industry can work in partnership with government, academia, NGOs and others to promote the sharing of perspectives and informed discussion.

Young people are the key to achieving and sustaining the vision of the knowledge driven economy. We welcome the recent Government and other proposals relevant to developing science education: the Department for Education and Employment documents on the post-16 learning framework and on Teachers ("Meeting the challenge of change"); the national curriculum changes (from September 2000) and the Nuffield Foundation recommendations; the Council for Science and Technology recommendations on Science Teachers; the Capital Modernisation Fund to upgrade science laboratories; the incentives to increase specialist teacher recruitment and to promote long-term teaching performance. These initiatives are all valuable, provided that there is shared understanding of the goals and methods of measurement for monitoring impact. However, we believe that there are significant challenges still to be faced in providing effective support to teachers and attracting high quality recruits into the profession. This may require new incentives, it certainly requires that teachers are themselves given the opportunity to contribute to developing the learning process and that teachers are given better support through continuous professional development schemes and appropriate administrative support.

SmithKline Beecham is committed to maintaining the reputation of the pharmaceutical industry as a leader in industry-schools liaison, at a local level—with links to more than 90 schools, events for more than 2,500 young people annually and hosting 50 work experience students this year—and more broadly. For example, we organise the Health Matters School Awards (secondary level school research projects in health-related subjects) across Europe and we sponsor science museum activities in several countries. We have worked with the British Association for the Advancement of Science during UK Science Week/Annual Festival to bring sixth-form students together from across Europe to learn about R&D and explore related social issues. We believe that our efforts with schools and the community at large have been highly useful—but there is room to do much more in an integrated way across Europe, First, however, it is necessary to find a mechanism to share best practice and we look to the forthcoming Science White Paper to provide a lead in proposing ideas to this end.

CONCLUDING REMARKS

Perspectives in national science policy and strategy have changed for the better since *Realising our Potential.* For example:

- initial scepticism about Foresight has been allayed by recognition of the value of building broader partnerships between academia and industry;
- R&D evaluation has become a routine objective embedded in research funder's expectations;
- the research community no longer assumes that concerns expressed by the public at large and their elected representatives can be countered by scientists merely speaking more loudly, scientists are now more ready to learn about public expectations, the effect of the media and the impact on Whitehall;
- the concerns expressed about declining public funding, the consequent decay in research infrastructure and employer difficulties in recruiting and academic collaboration were heard and have begun to be addressed by infusion of additional funds.

This progress is highly welcome but we must avoid the false dawns and frustrated expectations that characterised some earlier epochs in science policy. There is, of course, much more to be done in resolving the problems identified in the 1993 White Paper and taking forward the debate into the 2000 White Paper: prioritising public investment in science and maintaining long-term commitment to R&D; optimising the curriculum and its delivery in schools' science; promoting innovation across government; facilitating translation of R&D advances into improved health care and quality of life. Pervading all these issues is the co-operativity challenge—ensuring that government, academia, industry and the other research-funders work together to exploit the new opportunities. To reiterate our previous points, building partnership will require developing new forms of research infrastructure, for example, in constructing and sharing medical information databases; will require facilitation of technology transfer, will require a coherent, integrated view across government to promote innovation and avoid the silo budget mentality. The building of public-private partnership must remain central in UK science policy activities. It is essential to be radical in UK agenda-setting to these ends and in energising the next generation of scientists, innovators and policy-makers.

6 June 2000

APPENDIX 34

Memorandum submitted by Glaxo Wellcome

INTRODUCTION

1. Glaxo Wellcome is a research-based company whose people are committed to fighting disease by bringing innovative medicines and services to patients throughout the world and to the healthcare providers who serve them.

2. In 1999, Glaxo Wellcome invested £1.269 billion on research and development, of which £507 million was in the UK. Currently Glaxo Wellcome employs 9,270 staff in its R&D organisation, with 4,500 based in the UK and 2,700 in the US.

3. In 1999 Glaxo Wellcome led the UK's R&D Scoreboard for the fifth successive year[1], but despite this significant investment, we estimate that we carry out less than 1 per cent of the global research that is relevant to our business. Access to the 99 per cent of knowledge outside our business and access to the best scientists and engineers are critical for our success.

4. Glaxo Wellcome—or at that time Glaxo Group plc and The Wellcome Foundation Ltd—therefore supported the objectives of the 1993 White Paper.

GENERAL COMMENTS

5. At the time of the publication of the White Paper *Realising our Potential: a strategy for science, engineering and technology* in 1993, there had not been a government strategy for science and technology or any significant pronouncement, for over 20 years. It therefore fulfilled a clear need to create a national strategic vision around which government could recognise the need and importance of science, engineering and technology in the knowledge-driven economy. The objectives of the White Paper appeared to receive cross-government support, when published.

6. Over the last 10 to 15 years there has been a significant increase in the interaction between university and industry. It is arguable whether this would have happened anyway. But this is not the point—for the first time in some years the UK Government recognised the positive contribution science could make to people's lives and the UK economy.

7. The cornerstone of the House of Commons Science and Technology Committee's inquiry is "to inquire into and examine the impact of the 1993 White Paper—*Realising our Potential*". We would urge that care be taken not to judge this impact in terms of "success" or "failure". Rather it must be looked at in terms of an on-going strategic vision of the role science, engineering and technology play in a modern society and how the UK can continually review, develop and harness its research strengths.

8. In this paper Glaxo Wellcome hopes to highlight areas where there has been a significant impact but also identify where expectations have not been met or opportunities lost. We hope these will be viewed in a constructive light—the object must be to build on the 1993 White Paper and develop UK science, engineering and technology policy to address our needs today and develop a sustainable strategy for the future.

9. Science and innovation strategies can never stand still. Science and technology has moved forward rapidly since 1993. Perhaps the best illustration of this is on two fronts. First, the human genome project was still at the concept stage, yet it will be completed in an initial form this year. And second, the impact of the internet across society, enabling access to information that, in 1993, was not widely envisioned.

10. It must also be remembered that other countries are striving to enhance and improve their science, engineering and technology base. If the UK is to remain at the forefront of scientific research we cannot afford to stand still. The UK must sustain investment in research infrastructure and be able to train, retain and attract the best scientists.

11. As a global company, Glaxo Wellcome seeks interaction with the science and engineering base for three principle reasons:

- to access new knowledge that is of relevance to our business, especially in understanding the underlying cause and progression of disease, but also related to other aspects of our business wherever appropriate;
- to identify and recruit leading researchers and technically trained individuals that support our research effort; and
- access to vocational and applied courses that allow our staff to update their skills.

12. Whilst Glaxo Wellcome interacts with and supports the UK science, engineering and technology base in a variety of ways, the common denominator of all our collaborations is excellence.

13. As the leading company investing in R&D in the UK, Glaxo Wellcome believes and actively supports the research base. In 1999 over £17 million was spent supporting external collaborative research by our UK R&D organisation, covering research projects, Professorial chairs, supporting research and vocational training and clinical research fellowships. Access to an industrial environment is also important for the training of new research scientists, whether they subsequently enter an industrial or academic research environment. Glaxo Wellcome therefore currently supports over 260 active PhD studentships linked to 54 different universities across the UK and provides over 240 one-year placements for undergraduate students between their second and third years with full-time contracts. Finally in 1999 some £35 million was spent in the UK universities, hospitals and institutes to support the critical areas of clinical research and therapeutic trials.

1. The Extent to Which the Objectives Set Out in the 1993 White Paper, *Realising Our Potential,* Have Been Delivered

The annual publication of Forward Look to provide clear and up-to-date statement of the Government's Strategy for science, engineering and technology

14. The Forward Look was one of the key innovations of the White Paper. Its purpose, replacing the annual review, was "to give the industrial and research communities a clear and up-to-date statement of the Government's strategy". This is something that was warmly welcomed and when published, assisted in clarifying the importance each government department placed on science and technology. It is also likely that it encouraged those departments who were not already doing so, to crystallise their objectives from such spending.

15. However there are a number of concerns relating to the Forward Look. In particular there are two key issues:

- although presenting a holistic picture of funding, it appeared that departmental strategies were developed in isolation of each other; and
- the Forward Look has not been published annually since the 1993 White Paper—the momentum generated by its appearance was lost following the last publication in 1996.

16. GlaxoWellcome believes that the Forward Look should continue. However, perhaps for the reason that it was only published for three years, its impact is questionable. This is best illustrated by the fact that total civil departments expenditure on SET has dropped in real terms from £1,922.1 million to £1,288 million between 1986–87 and 1998–99[2]. This period coincides with key issues such as the increasing prevalence of antibiotic resistant E. coli, BSE and the use of GM crops. Unless there were dramatic gains in research efficiency, the decline in spending is counter-intuitive considering the need for decision making to be based on sound scientific advice.

The creation of Technology Foresight (now Foresight)

17. The Technology Foresight programme has been positive on a number of fronts. Most importantly it has created a framework for identifying opportunities in terms of both markets and emerging technologies. It has drawn in a number of players into the process and created a mechanism that allows representatives of diverse communities to express and discuss the technology developments.

18. However there have been a number of criticisms of the programme, including:

- the haste with which the first iteration was carried out;
- the poor penetration to reach those who would benefit from it most, especially in the industrial sector;
- the lack of an on-going strategy after the publication of the 15 panel reports in Spring 1995—this led to a loss of momentum, poor communication and slow implementation by government; and
- the relatively small impact of the recommendations or outcomes in terms of government strategy and expenditure on the science base, especially in terms of civil department spend.

19. However Glaxo Wellcome believes that the programme should continue and must be a stronger tool for development of government policy. The current round of Foresight has introduced a number of new concepts—such as re-orienting the panels and introducing the knowledge pool, a resource which is open to all. Re-invigorating Foresight is essential if the on-going programme is not to stagnate.

The abolition of the Advisory Council on Science and Technology and its replacement with the Council for Science and Technology "to help ensure that the Government benefits from outside independent and expert advice when deciding on its own research spending priorities"

20. The replacement of the "ACST" with the "CST" is not the key issue. That must be the impact such an independent advisory body, whatever its name, has within Government and the perception of it as a leader in the external environment.

21. Undoubtedly in the first four to five years of its establishment, the profile of the CST was low and consequently its role and influence unclear. However in 1997–98 its *modus operandi* was reviewed and a more open approach to its work programme adopted. In 1999 and 2000 there have been a number of reports that have been both hard hitting and influential in their impact[3]. This has originated from work programmes established in 1998 and should continue in the future.

The reorganisation of the Research Councils with modified management structures and new mission statements which made more explicit their commitments to wealth creation and the quality of life

The creation of the post of Director-General of the Research Councils and the absorption of the functions of the Advisory Board for the Research Councils into the Office of Science and Technology

22. We welcomed the reorganisation of the Research Councils (RCs) with modified management structures and new mission statements which made more explicit their commitments to wealth creation and the quality of life and feel that significant benefit has come from these changes.

23. Of all the RCs, the EPSRC[4] arguably leads the field in consulting on research needs with different communities. Each Council, although not organised in identifical fashion, has created mechanisms to actively engage researchers in shaping forward strategies, whether based in academe or industry. The EPSRC for example annually publishes a "landscape" document outlining research areas, following extensive consultation with "user" communities.

24. There has been concern that the approach taken by the RCs to engage with industry has led to a reduction in the amount of funds available for curiosity-driven or fundamental research. However as indicated in *SET Statistics 1999,* 60 per cent of Research Council (RC) funding supports "basic" research according to the Frascati definitions (see Table 1). Assuming the peer review mechanisms are equitable then the research funded is likely to be selected on the basis of quality and excellence rather than whether it is fundamental, strategic or applied.

Table 1

EXPENDITURE BY THE RESEARCH COUNCILS ACCORDING TO THE TYPE OF RESEARCH AS DEFINED BY FRASCATI[5]

Type of Research Activity	*% of £1.265 billion in 1997–98*
Basic-pure	21%
Basic-oriented	39%
Applied-strategic	31%
Applied-specific	8%
Experimental development	1%

25. Glaxo Wellcome has a number of examples where collaboration with the RCs is addressing a significant major need. These include:

- The Edward Jenner Institute for Vaccine Research, Compton, Berkshire: Glaxo Wellcome provided £40 million over 10 years from 1994, to establish the Jenner Institute in collaboration with the BBSRC, the MRC and the Department of Health. The RCs are expected to sustain long-term support after the first 10 years, although the Institute must remain a centre of scientific excellence.
- Working with EPSRC, Glaxo Wellcome has stimulated the creation centres of excellence in combinatorial chemistry to support research and postgraduate training.
- The Industrial Quota CASE Awards, pioneered by EPSRC, provide an effective mechanism where young scientists can gain their doctorates carrying out research in an industrial environment, while ensuring academic rigour through strong links with their host university.

The launch of a new campaign to spread understanding of science among school children and the public

26. Earlier this year the House of Lords published a report on *Science and Society*[6]. This report crystallised the increasing view that it is not the public understanding of science that is key, but rather the two-way communication or engagement of the "public" with scientific developments. As Glaxo Wellcome's submission commented[7] "a more realistic approach would be to encourage scientists understanding of the public".

27. There are three keys to ensuring an informed debate:

- first, an awareness of the scientific process, encompassing the core issues of uncertainty, hypothesis testing and debate;
- second, engaging young people in the debate on the application and advancement of science in a modern society; and
- third, that we provide a sound science education within the national curriculum framework.

28. We cannot expect every individual to have an "understanding of science"—indeed many scientists specialising in one field are largely ignorant of advances in others. But what all scientists share is the understanding of the process.

29. The "new campaign launched to spread understanding of science among school children and the public" has had mixed success, as can be seen in the recent debates surrounding GM crops. The associated furore can be equated to the outcry when the first heart transplants took place. These outcries were driven not just by the uncertainty in the public's mind, but significantly by the associated press coverage. It is difficult to see how the next contentious scientific issue can be handled any differently with the tabloid spin placed on most scientific reports today.

30. Glaxo Wellcome currently works both with the Royal Institution of Great Britain (RI)—by supporting the Christmas Lectures—and the British Association for the Advancement of Science (BAAS)—as one of two principal sponsors for *Creating Sparks,* with our funding centred on participative experiments to engage schools and families.

31. Both of these institutions have a particular focus, the RI around its lectures and discourses at its facility in Piccadilly and the BAAS in its reach across the country, especially focusing on its young people's section (BAYS clubs).

32. Whilst both the RI and the BAAS have areas of success as independent organisations, there is a strong argument for bringing them together. This would provide an opportunity to move away from the "professional amateurism" that has historically typified the UK efforts on engaging the public in science and create a well-resourced facility that would both have a significant base in London and outreach across the UK.

33. The joined body could be based at the RI in Piccadilly, for which a major refurbishment plan is being developed. However this would only be possible if the Davy-Faraday Research Laboratory could be moved out of the building. The argument against this is history—there has been an active laboratory at the RI since its inception. However the laboratory already has strong links to University College London and moving this facility would give the excellent researchers therein, access to new and modern facilities that are singularly absent in their current Piccadilly home. Such a move could be supported by exceptional funding through, for example the Joint Infrastructure Fund and modern IT and communication links could ensure that the close historical association with the RI continues.

2. Whether the Objectives and Themes of the 1993 White Paper Remains Appropriate to the Development of a Strategy for Science, Engineering and Technology and, if not, what other Themes and Objectives would be More Beneficial

34. These objectives and themes remain valid today. It is arguable that in the year 2000, the importance of science and technology in creating a dynamic and successful economy is greater than in 1993. A clear and consistent science and innovation strategy is the foundation of the UK remaining an attractive country in which to invest. It is also important both to ensure that the UK can capitalise on its investment in science and technology and provide the well-trained and entrepreneurial individuals upon which a modern economy depends. In the 1993 White Paper conclusion[8] it states that:

> "The Government's strategy is to improve the nation's competitiveness and quality of life by maintaining the excellence of science, engineering and technology in the United Kingdom. It will do so by:
>
> — developing stronger partnerships with and between the science and engineering communities, industry and the research charities;
>
> — supporting the science and engineering base to advance knowledge, increase understanding and produce highly-educated and trained people;
>
> — contributing, according to the United Kingdom's strengths and interests, to the international, and particularly European, research effort;
>
> — continuing to promote the public understanding of science and engineering;
>
> — ensuring the efficiency and effectiveness of government-funded research.

The science and technology programmes undertaken in support of departments' policy, statutory, operational, regulatory and procurement responsibilities will contribute to this overall strategy".

35. The key issue in delivering an environment in which science and technology based companies can flourish is that government policy is consistent across Whitehall. This relates not just to investment in science and engineering, but also in terms of the fiscal and regulatory environment. Therefore an excellent science base will avail nothing if there is not a stable economy and minimum regulation to encourage the establishment of small high technology companies and facilitate the appropriate exploitation of science and technology in larger ones.

36. It is essential that trans-departmental science and technology is effectively co-ordinated across government. The current and previous Chief Scientific Advisers have both worked effectively at co-ordinating the Chief Scientists and Prof Sir Robert May's guidelines on the use of scientific advice in policy making provide good guidance. However at the most senior level in government departments there is still a discontinuity with strategic investment in science policy.

37. In reality science, engineering and technology strategy still does not have the status, priority and power that it rightly deserves. To that end Glaxo Wellcome advocates the following reorganisation which would provide the necessary authority and central government leadership:

— the Chief Scientific Advisor (CSA), along with the Trans-departmental Science and Technology Group in the OST should be moved to the Cabinet Office, including the Foresight secretariat. This would strengthen the role of the CSA in co-ordinating and leading science across Westminster. It would also remove any confusion between the possible roles of the Director General of the Research Councils (DGRC) and the CSA (see next point) and reinforce the latter's role as the adviser to the Prime Minister;

— the DGRC should assume control of the OST. The OST should remain ring-fenced in DTI;

— the portfolio for science and technology should be represented at Cabinet level by a dedicated Minister.

38. If this re-organisation occurred the secretariat that supports the Council for Science and Technology (CST) should also move to the Cabinet Office. This would provide greater leverage to the respective roles of the CST and the CSA, both in terms of trans-departmental co-ordination and the latter's position as the principle adviser to the Prime Minister on scientific issues.

3. Whether Attempts to Deliver the Proposals of the 1993 White Paper have Resulted in a Culture Change Across, or in Parts of, the Science, Engineering and Technology Base, and, if so, What is the Nature of this Change and How has it been Demonstrated

39. It is undoubtedly true that there has been a significant shift in attitudes across the science, engineering and technology base over the last 10 years. Academics are willing to both collaborate with industry and consider establishing start-up companies to exploit opportunities. Research of relevance to industry is no longer seen as of peripheral interest.

40. It is arguable that this change in attitude would have happened anyway, driven by what was happening in other countries, especially the United States, and fuelled by advances in science and technology. There has also been a blurring of boundaries between fundamental, strategic and applied research.

41. This question can only be answered through an experiment with a good control against which to judge any changes—obviously an impossible scenario. Many indicators that would be selected against which to judge success, such as an increase in the number of collaborations between industry and universities, would have happened anyway, but the 1993 White Paper spawned initiatives that are likely to have encouraged such links, accelerating the number created.

42. A more appropriate marker is whether the UK has improved its position in terms of stimulating the exploitation of research, in advance of our key competitor countries. For example, it could be claimed that the White Paper was one aspect that has led to a culture change both in universities and government that has stimulated the creation of biotechnology firms.

43. But bald figures on a number of biotechnology companies do not provide the whole picture. The 1999 Ernst & Young European Life Sciences Report[9] noted that the UK had around 270 entrepreneurial biotechnology companies compared to less than 230 in Germany, whilst in 2000[10] this order was reversed, with Germany listing a few more than the UK's 280. Such direct comparisons are dangerous as they hide the fact the UK biotech sector is more mature in terms of both the size of companies and the numbers publicly listed.

44. Perhaps of greatest concern is that although many leading science and engineering based companies, especially in the pharmaceutical sector, have deepened their interactions with academe, the rest of UK industry remains aloof. The poor track record of investment in R&D by many sectors of industry in the UK remains a good indicator of this problem. With the exception of the pharmaceutical sector, chemicals, IT and other SET sectors continue to under-invest in R&D compared to competitors overseas as highlighted in the 1999 R&D Scoreboard[11] (R&D investment as a percentage of sales in UK v overseas companies: Pharmaceuticals 15 per cent v 13.5 per cent, Chemicals 1.7 per cent v 6.1 per cent, Engineering and Machinery 1.6 per cent v 3.3 per cent. Electronic and Electrical 3.2 per cent v 5.3 per cent, Software and IT services 4.8 per cent v 13.6 per cent).

45. The recommendations of the House of Commons Science and Technology Committee on "Engineering and Physical Sciences Based Innovation"[12] are pertinent to the problems of engaging companies in the benefits of science based innovation.

4. THE GOVERNMENT'S RECENT CONSULTATION ON SCIENCE AND INNOVATION STRATEGY STATED THAT "THE AIM IS TO USE THE UK'S EXCELLENCE IN SCIENCE TO ACHIEVE IMPROVEMENTS IN OUR NATIONAL INNOVATION PERFORMANCE AND SO TO IMPROVE THE COMPETITIVENESS OF THE ECONOMY AND THE QUALITY OF EVERYONE'S LIFE" . . . DO YOU AGREE THAT THESE ARE APPROPRIATE AIMS FOR A NATIONAL STRATEGY FOR SCIENCE?

46. Glaxo Wellcome fully supports the objectives for the coming Science and Innovation White Paper set out by the Government in its consultation paper earlier this year. However there are two issues that must be addressed:

- the White Paper needs full support across government departments; and
- the need to invest in fundamental science of the highest quality is recognised.

WHAT DO YOU BELIEVE SHOULD BE THE MAIN FEATURES OF A MODERN STRATEGY FOR SCIENCE, ENGINEERING AND TECHNOLOGY AND WHY?

47. There are five key aspects to a modern strategy for science, engineering and technology:

- investment in excellence to support leading research infrastructure focused on high quality research groups;
- a clear strategic framework for science and technology that evolves;
- consistent leadership from government and coherent implementation of science-based policies across departments;
- a stable macro-economic environment that supports a climate of innovation, entrepreneurship and risk taking; and
- a positive approach to engaging the public in debating and informing, but not dictating, the application of scientific research.

48. Underpinning all this must be a continuing focus on science education in schools. Without a good grounding in science and the ability to attract the brightest pupils into science, engineering and technology the science and innovation strategy currently being prepared will not have the desired impact. Glaxo Wellcome supports the steps being taken by the Government to address the key issues in science education—especially attracting new science teachers and focusing on what turns pupils off as they progress through school.

Investment in excellence

49. The UK must ensure that it maintains its investment in science, engineering and technology to produce both the next generation of leading scientists and the knowledge upon which industry increasingly depends. Glaxo Wellcome relies upon this dual supply of people and knowledge.

50. In 1998 Japan increased its investment in science by more than the UK's total science budget. This year the US President is requesting Capitol Hill to approve a 17 per cent increase in spending to support science. If approved, this will be the second consecutive year of double-digit science budget growth in the US. The UK must not only note that other countries are focusing on the importance of science and technology in creating a dynamic economy, but respond effectively by investing in high quality research infrastructure and leading scientists.

Clear strategic framework for science and innovation policy

51. The current science and innovation White Paper being developed by the UK Government should build and develop upon the 1993 White Paper. Neither should the 2000 White Paper be the last, the UK must continually adapt and evolve its policy as the rate of technological change accelerates and new social issues arise that have a significant scientific component.

Consistent leadership from government

52. The application of science is affected by many different government departments: the OST in the Department of Trade and Industry is responsible for funding research projects and postgraduate training; the DfEE is responsible for science education in schools and the block grant of the dual funding arm; HM Treasury is responsible for creating an appropriate fiscal environment in which entrepreneurial companies and larger companies can invest for the long-term; and other departments, such as MAFF and DoH, must invest in R&D to inform policy making.

53. It is essential that one government department does not inhibit another's policy objective at the very least and preferably all support key government-wide objectives.

54. The Government's commitment to innovation must also be consistently demonstrated in the policies and activities of public sector agencies. For example, the National Health Service has lagged behind health providers in other advanced economies in its take-up of new treatments and technologies. The Government

has set up the National Institute for Clinical Excellence (NICE) with the welcome aim of providing faster access to modern treatments. However, early experience of NICE has given rise to concerns that its *modus operandi* could act as an additional barrier for new medicines to surmount, on top of the well-established requirements to demonstrate quality, safety and efficacy.

55. A fundamental problem with NICE's approach is its premise that everything that needs to be known about a new medicine can be established through expanded clinical trials. However, experience shows that the true value of a medicine can only be ascertained after it has been introduced into the healthcare environment and used extensively in every day clinical practice. Any attempt to reach a definitive assessment of the value of a new medicine before it is recommended for use in the NHS can only act as a significant disincentive to the introduction of innovative medicines into the UK, which would prevent real benefits reaching patients.

A stable macro-economic environment

56. If the UK does not sustain a stable environment in which new companies can be established and existing companies invest in R&D for the long-term, then all the UK's investment in education, research and initiatives to support innovation will be to no avail.

Debating and informing the application of science

57. The UK Government must heed the points raised in the House of Lords Science and Technology Committee's report on *Science and Society*[13]. Most importantly, as is already emerging, the relationship between scientists and the public needs to be reconsidered. Whilst the public should not be able to dictate the future direction of research, Government, industry and universities must be able to communicate what they are trying to achieve and take into account public attitudes.

CONCLUDING REMARKS

58. The 1993 White Paper was a landmark in science policy. It represented the first government statement on the role of science, engineering and technology for around 20 years. This and the planned 2000 White Paper must not be the last. During the seven intervening years, there have already been significant advances in science and technology that are transforming the relationships between scientists in industry and academe and also between all scientists and the "public".

59. Whether all the changes witnessed over the intervening years can be put down to the 1993 White Paper is arguable. What is certainly true is that it brought together a variety of constituencies to discuss relevant policy and put in place a framework for exploiting science to economic benefit and focus on its role to enhance the quality of life of all in the UK.

60. Glaxo Wellcome, and other major companies, relies on the products of the science base—namely highly skilled people and knowledge. The 1993 White Paper has helped in focusing successive UK Governments to support science and technology. It is essential that this continues if the UK is to attract and sustain globally competitive industries.

NOTES

[1] *The UK R&D Scoreboard 1999: company data.* June 1999. DTI (URN 99/215).

[2] *Science, engineering and technology statistics 1999.* OST.

[3] Review of S&T Activity Across Government, CST July 1999.
Technology Matters, CST, February 2000.
Science Teachers, CST, February 2000.

[4] The Academic Liaison Manager at GlaxoWellcome, is a member of the Technical Opportunities Panel in EPSRC.

[5] After Figure 3.3, *SET Statistics 1999: A handbook of science, engineering and technology indicators,* The Stationery Office, August 1999, Cm 4409.

[6] *Science and Society.* Third report of the House of Lords Select Committee on Science and Technology, Session 1999–2000.

[7] Paragraph 36. A Memorandum by Glaxo Wellcome to the House of Lords Science and Technology Committee Inquiry into "*Science and Society*". July 1999.

[8] Paragraph 8.2, page 68 *Realising our potential: a strategy for science, engineering and technology,* May 1993, HMSO, Cm2250.

[9] Page 4, *Ernst & Young's European Life Sciences Report 99: sixth annual report,* April 1999, Ernst & Young International Ltd.

[10] page 6, *Ernst & Young's European Life Sciences Report 99: sixth annual report,* April 1999, Ernst & Young International Ltd.

[11] *The UK R&D Scoreboard 1999—Commentary and Analysis* and *Company data.* DTI June 1999.

[12] *Engineering and physical science based innovation.* Second Report of the House of Commons Science and Technology Committee Session 1999–2000.

[13] *Science and Society.* Third report of the House of Lords Select Committee on Science and Technology, Session 1999–2000.

June 2000

APPENDIX 35

Memorandum by the Scottish Higher Education Funding Council

INTRODUCTION

1. The Scottish Higher Education Funding Council (SHEFC) is a Non-Departmental Public Body, sponsored by the Scottish Executive Education, Enterprise and Lifelong Learning Department. SHEFC was established under the terms of the Further and Higher Education (Scotland) Act (1992) and has a remit to fund the provision of education and the undertaking of research in higher education institutions (HEIs) in Scotland.

SUMMARY

2. The Scottish Higher Education Funding Council is one of the major funders of the science base in Scotland. In 2000–01, the Council's total budget will be about £615 million, a significant proportion of which will be allocated to support teaching and research in SET in Scotland's universities and colleges. The Council has a clear interest in the development of science strategy, both at the UK and the Scottish level.

3. In this response, the Council has drawn attention mainly to the impact of the 1993 White Paper on its own activities although, where appropriate, we offer some comments on its wider impact. Our response also provides some comments on the development of a future strategy for science, engineering and technology.

THE OBJECTIVES OF THE 1993 WHITE PAPER

4. One of the main objectives of the White Paper was to ensure that the science, engineering and technology base was, in the future, used more effectively to enhance the UK's competitiveness and to bring improvements in the public services and the quality of life. The White Paper set out a number of measures, or policy initiatives, designed to achieve this key objective.

5. The Council's view that it is probably too soon to tell whether the main objectives of the White Paper have been met, or are likely to be met. There are two problems in seeking to assess the effectiveness of the White Paper. Firstly, the Paper mainly proposed changes in the way in which the science base should be managed and funded in the future. It did not, however, set out measurable targets for the future contribution of the science base to wealth creation and, clearly, the lack of such targets makes if difficult to assess the real impact of the White Paper on the UK's competitiveness. Having said that, the UK Higher Education Funding Councils are currently developing plans for an annual survey of higher education-business interactions and of commercialisation activity in the higher education sector. This survey should allow us to establish a baseline level of activity in higher education from which improvements in later years can be measured.

6. The second difficulty in assessing the full impact of the White Paper is that many of the policy initiatives and structural changes, that the Paper proposed took time to implement. For example, one of the main outcomes of the Paper was the Technology Foresight exercise and the publication of the first report from the Steering Group in 1995[1]. However, this report will probably not have had an immediate impact since many of the bodies that have played an essential role in taking forward its conclusions, including the Higher Education Funding Councils and the Research Councils, required a further period of time to develop new policies and initiatives in response to the report.

7. In the case of SHEFC, the Council published a consultation document (Addressing Technology Foresight) which invited views on how it might best respond to Technology Foresight and set out a number of options. It subsequently published an Action Plan in 1996 (Addressing Technology Foresight: Action Plan) setting out plans to establish a major grant scheme (the Research Development Grant) which was intended to help improve the fit between the research capability and Scottish HEIs and the long-term needs of society, as identified through the Foresight Programme.

8. The Research Development Grant (RDG) scheme was introduced in 1997–98 and, to date, the Council has funded a total of 53 proposals to the value of £26 million (A list of the awards classified by Foresight panels is attached as Annex A to this Memorandum.) The Council has also recently announced the funding for a further 16 awards for next year, totalling £12 million in value. It has not yet been possible to evaluate the effectiveness of the RDG scheme as a mechanism for addressing Foresight priorities. However, with the support of the Scottish Executive, the Council is currently developing an evaluation programme, which, among other things, will seek to examine the extent to which RDG awards appear to be addressing Foresight priorities. The findings from the evaluation are expected to be available early next year.

9. Overall, the 1993 White Paper appears to have been successful in stimulating changes in the organisation and management of the publicly funded science base, and in establishing clear priorities for funding through exercises such as Foresight. However, it is not yet clear that there is sufficient evidence to assess whether the changes have been successful in meeting the main objectives of the White Paper in enhancing economic growth.

The Continuing Appropriateness of the Themes and Objectives in the 1993 White Paper

10. The Council believes that the broad themes and objectives of the White Paper continue to remain appropriate. In particular, there continues to be a need for the UK as a whole to ensure that it maximises its ability to exploit its investment in the science base. Realising our Potential emphasised that it was essential to maintain the excellence and diversity of science, technology and engineering in the UK if the nation is to increase its international competitiveness. In doing so, it also reaffirmed the Government's commitment to the dual support system for funding research in the UK. The Council welcomed this commitment and the evidence suggests that the UK continues to have a broad and diverse science base, with a balanced portfolio of high quality research ranging from basic, blue-skies research, at one end of the spectrum, to highly applied and commercially relevant research at the other.

11. However, a key issue continues to be whether we have in place effective policies and funding arrangements to support technology transfer and diffusion—or knowledge transfer as it is now called—so as to stimulate innovation. To give one example, Bob May has highlighted in the area of Biotechnology that the UK appears to be a clear second to the USA in the citation of research papers, but is still some way behind the USA and Japan in the ownership of patents[2]. The rate of knowledge transfer that, in turn, potentially affects the rate of innovation also remains an important issue. At the same time, the evidence suggests that UK expenditure on R&D has declined relative to that of our major OECD competitors.

12. It is clear therefore that an important theme for a future science strategy must be on improving the contribution that the science base can make to the innovation process. In particular, there is a need to encourage greater investment in R&D by business and industry, and to seek ways of exploiting the science base more effectively for the commercial benefit of the UK. In this we welcome the work, at the UK level, to develop a coherent Science and Innovation Strategy and, in Scotland, the work to develop a Scottish Science Strategy. We believe that the timing of this work is critical since other industrialised countries appear to be developing similar strategies. For example, in Canada, a report published last year by the Government's Advisory Council on Science and Technology put forward a number of recommendations for the federal funding of research aimed at increasing the role of the science base in the innovation process[3].

13. The second main theme that we believe that a new science strategy should address is that of co-ordination. There are two dimensions to this. First, there is a need to ensure that there is continuing close co-ordination between different government departments across the UK. This is particularly important in the context of devolution. In this regard, the Council concurs with many of the arguments contained in the 1999 report of the Royal Society of London and the Royal Society of Edinburgh[4] for the benefits that Scotland gains from being part of the UK science base, and for the need for Scotland to remain a well integrated part of the UK science base. The second dimension to this is to ensure that there is co-ordination between the different funding agencies, including the Funding Councils, Research Councils and enterprise agencies such as the RDAs, or Local Enterprise Companies in Scotland, all of whom have a role to play in stimulating innovation.

14. Our view overall is that a new science strategy should seek to build on the objectives of the 1993 White Paper, but that it should ensure that the underlying policies, and the mechanisms to deliver these policies, continue to be appropriate. In particular, there should be a renewed emphasis on innovation and on co-ordination between government departments across the UK and between the funding bodies.

A Culture Change Across the Science, Engineering and Technology Base

15. It is difficult to assess with any hard evidence whether the attempts to deliver the proposals of the 1993 White Paper have resulted in a culture change across the SET base. However, our perception is that there has been a change in the higher education SET base and that this is manifested in two ways. Firstly, it appears that there is a greater awareness within the higher education sector of the need to undertake research in the

context of wider societal needs, including commercial needs. This does not mean, of course, that all research is driven by immediate economic, social or cultural needs. It is simply that researchers appear to be more willing to consider the potential applicability of their research and, where appropriate, to develop links with the potential users of this research.

16. In part, this is probably a response to changes in the funding of research. For example, the Council's Research Development Grant has the specific objective of helping to improve the fit between the research capability of Scottish HEIs and the long-term needs of society, and so it is perhaps not surprising that this is reflected increasingly in institutional research strategies. However, since 1996, the Council has asked institutions to provide annual reports, indicating how they have used Foresight in developing their research strategies. These reports indicate that most institutions have also sought to embed the findings of Foresight in their strategic research plans. Examples include the adoption of particular Foresight priorities in the planning processes at different levels of the institution, the dissemination of Foresight information to staff, ring-fencing budgets for Foresight purposes and requiring Foresight priorities to be taken into account in applications for research funding from public sources.

17. The other area where there appears to have been a change in attitudes or culture, at least in Scotland, is in the organisation of research and the resources to support research. In particular, there is a greater willingness among institutions to collaborate with each other, including between institutions with very different backgrounds and histories. The forms of collaboration range from formal institutional partnerships, such as the "synergy" partnership between the Universities of Glasgow and Strathclyde, to more local collaboration in the sharing of research facilities or equipment. The majority of proposals for support from the Councils' Research Development Grant scheme now involve partnerships between higher education institutions in Scotland, and between institutions and external bodies. Another notable feature of the applications to the RDG scheme is the number of proposals to establish "Scottish Centres of Research" which, rather than serving the interests of only one institution, involve collaborative partnerships that build on complementary strengths of different institutions. We believe that these developments have served to strengthen the science base in Scotland and are consistent with the objectives of the 1993 White Paper.

A National Strategy for Science

18. The Council agrees that the aims that the UK Government has set out for a modern SET strategy are appropriate and, indeed, there is a significant degree of consonance between these aims and those in the 1993 White Paper. We believe that this is helpful since it implies an evolution from the objectives of the original White Paper, rather than a fundamental change. As we have already highlighted, we believe that an important issue for the new strategy will be that of co-ordination across the UK and between different funding agencies. We also believe that responsibility for implementing the aims of the strategy need to be clearly defined, including clarifying boundaries of responsibility between different government departments and funding agencies.

20. The Government's recent consultation was right to highlight the need to improve the flow of skilled scientists and engineers to business. However, we believe that one of the most important factors that influences the availability of skilled scientists and engineers to work in industry and beyond is the number of school pupils studying science who progress into higher education and, thereafter, into postgraduate study and research. (Although, there are also clearly other external factors including the state of the labour market and the economy, as well as remuneration levels and conditions of service for researchers which will be relevant.) A further issue that the proposed Science and Innovation Strategy might therefore consider is that of science and education, including the education, training and career development of science teachers.

21. Finally, under this heading, the Council agrees that one of the aims of the Science and Innovation Strategy should be to ensure that the UK is able to take advantage of the globalisation of research. However, we believe that it is important that the role of the Foresight exercise in helping to identify the areas of the global research effort where the UK can contribute most should be fully recognised in the strategy.

The Main Features of a Modern Strategy for Science, Engineering and Technology

22. The Council's view is that a modern science strategy for SET must be characterised by an emphasis on the development and maintenance of a flexible, diverse scientific research base that is excellent by international standards. In particular, the Higher Education Funding Councils have a key role to play in ensuring that the UK has a strong basic research capacity which will provide the foundation for strategic and applied research that are essential to the development of the knowledge-based economy and society.

23. However, investment in a basic scientific research capacity is not by itself a sufficient condition to achieve enhanced economic growth and improvements in the quality of life. A second main feature of a strategy therefore is the development of effective mechanisms for knowledge transfer and the commercialisation of the research base. This requires stimulating the supply of knowledge, technologies and skills from the science base; and, secondly, increasing and improving the demand from the industry/business

sector. A copy of a response that the Council has provided to the current consultation by the Scottish Executive on the development of a Science Strategy for Scotland is attached to this Memorandum as Annex B[5]. This response sets out in more detail the Council's views on the main features of a science strategy.

NOTES

[1] Progress through Partnership. Report from the Steering Group of the Technology Foresight Programme 1995. Office of Science and Technology. 1995.

[2] The Scientific Investments of Nations. Robert M May. Science. Vol. 281. 3 July 1998.

[3] Public Investments in University Research: Reaping the Benefits. Report of the Expert Panel on the Commercialisation of University Research. ACOST. May 1999.

[4] Devolution and Science: A Report by a Joint Working Group of the Royal Society of London and the Royal Society of Edinburgh. April 1999.

[5] *Not printed*

20 June 2000

Annex A

SCOTTISH HIGHER EDUCATION FUNDING COUNCIL: RESEARCH DEVELOPMENT GRANT AWARDS CLASSIFIED BY FORESIGHT PANELS

SECTOR PANELS

BUILT ENVIRONMENT AND TRANSPORT

Lead HEI	*Title*	*Round*	*£k*
Napier, University of	Extending Research Capability in Transport Research	1	695
Paisley, University of	Development of an outdoor facility for masonry and concrete research	1	345
Glasgow Caledonian University	Centre for Advanced Built Environment Research	2	350

Total: 1,390 (5.2%)

CHEMICALS

Lead HEI	*Title*	*Round*	*£k*
Aberdeen, University of	Development of Aberdeen Protein Facility	1	495
St Andrews, University of	A Catalyst Evaluation and Optimisation Facility	1	750
Strathclyde, University of	Process Analysis and Control Technology	1	227

Total: 1,472 (5.5%)

DEFENCE, AEROSPACE AND SYSTEMS

Lead HEI	*Title*	*Round*	*£k*
Strathclyde, University of	A Centre for Ultrasonic Engineering (CUE)	2	460

Total: 460 (1.7%)

ENERGY AND NATURAL ENVIRONMENT

Lead HEI	*Title*	*Round*	*£k*
Edinburgh, University of	Centre for Research into Contaminant Migration in the Terrestrial Environment	2	500
Glasgow, University of	Centre for Economic Renewable Power Delivery	2	620
Paisley, University of	Interdisciplinary Initiative for Waste and Pollution Management	2	270
Aberdeen, University of	Scottish Offshore Materials Support Facility	3	775
Stirling, University of	Centre for Environmental History and Policy	3	485
Strathclyde, University of	Terahertz to Optical Pulse Source (TOPS)	3	570

Total: 3,220 (12.0%)

FINANCIAL SERVICES

Lead HEI	*Title*	*Round*	*£k*
Strathclyde, University of	Interdisciplinary Research in Investment Science	1	440
Heriot-Watt University	Edinburgh Multidisciplinary Consortium for Advanced Nonlinear Analysis of Complex Systems	2	290

Total: 730 (2.7%)

FOOD CHAIN AND CROPS FOR INDUSTRY

Lead HEI	*Title*	*Round*	*£k*
Heriot Watt University	Provision of a Facility in Cereal Genetic Engineering	1	99
Stirling, University of	Aquatic Resource Genetics—AQUAGENE	1	478
Edinburgh, University of	The Edinburgh University Centre for the Application of Neurobiology in Animal Welfare Research	2	510
Robert Gordon University	Development of an Enhanced Facility for Food Research	2	420

Total: 1,507 (5.6%)

HEALTHCARE

Lead HEI	*Title*	*Round*	*£k*
Edinburgh, University of	Establishment of a DNA sequencing and genome analysis Core facility for development and application of Molecular Diagnostic Techniques	1	350
Glasgow, University of	Micromachining of "On-Chip" Bio-Analytical	1	498
Queen Margaret College	Scottish Centre for Research into Speech Disability	1	320
Aberdeen, University of	Development of a Radiochemistry Facility for Positron Emission Tomographic (PET) Imaging	2	450
Edinburgh, University of	Centre for Interactive Image Analysis	2	540
Glasgow, University of	Resource Centre for Genome Scanning Strategies in common Polygenic Disorders	2	430
Strathclyde, University of	Collaborative Centres for Drug Delivery Research	2	500
Dundee, University of	SIMBIOS	3	950
Glasgow, University of	Centre for Mathematical and Computational Science in Medicine	3	635
Heriot-Watt University	Centre for Theoretical Modelling in Medicine	3	425
Strathclyde, University of	Advanced Optical Microscopy	3	630

Total: 5,728 (21.3%)

INFORMATION, COMMUNICATIONS AND MEDIA

Lead HEI	*Title*	*Round*	*£k*
Abertay Dundee, University of	The EPICentre-Reshaping Interdisciplinary Research at UAD	1	355
Glasgow School of Art	Virtual Design Institute	1	650
Glasgow, University of	Revelation: A foundation for advanced and precise communication experiments	1	665
St Andrews, University of	Prototype Creation Laboratory in Photonics	1	584
Dundee, University of	A Centre for the Design and Fabrication of Microengineered Chemical Sensors	2	652
Strathclyde, University of	Design Cluster for Systems Level Integration	2	500
Abertay Dundee, University of	IC-CAVE	3	500
Edinburgh, University of	MEMS; CLIMACS	3	1,095
Glasgow, University of	Michelangelo	3	680
Glasgow, University of	VIDEOS	3	650

Total: 6,331 (23.6%)

MARINE

Lead HEI	*Title*	*Round*	*£k*
Heriot-Watt University	Centre for Marine Biodiversity	3	480

Total: 480 (1.8%)

MATERIALS

Lead HEI	*Title*	*Round*	*£k*
Dundee, University of	A Research Facility for Developing High Resolution Electronic Structures	1	175
Strathclyde, University of	Gallium Nitride Materials and Devices	1	300
Scottish College of Textiles	The Scottish Centre for Biomedical Materials	2	540
Paisley, University of	Centre for Thin Film Coatings	3	1,225

Total: 2,240 (8.3%)

RETAIL AND CONSUMER SERVICES

Lead HEI	*Title*	*Round*	*£k*
None			

Total: 0 (0.0%)

THEMATIC PANELS

AGEING POPULATION

Lead HEI	*Title*	*Round*	*£k*
Edinburgh, University of	A Centre for the Study of the Ageing Brain	1	422
Stirling, University of	Unit for Social Research in Dementia	1	464

Total: 886 (3.3%)

CRIME PREVENTION

Lead HEI	*Title*	*Round*	*£k*
None			

Total: 0 (0.0%)

MANUFACTURING 2020

Lead HEI	*Title*	*Round*	*£k*
Glasgow School of Art	Rapid Design and Manufacturing Research Centre	3	385

Total: 385 (1.4%)

UNDERPINNING THEMES

EDUCATION, SKILLS AND TRAINING

Lead HEI	*Title*	*Round*	*£k*
Glasgow Caldeonian University	Centre for Research in Lifelong Learning	3	410
Stirling, University of	The SCOTLANG Project	3	675

Total: 1,085 (4.0%)

SUSTAINABLE DEVELOPMENT

Lead HEI	*Title*	*Round*	*£k*
Aberdeen, University of	The Arkleton Centre for Rural Development Research	2	420

Total: 420 (1.6%)

UNASSIGNED

Lead HEI	*Title*	*Round*	*£k*
Edinburgh, University of	The Scottish Universities' Policy Research and Advice network (SUPRA): Science, Technology and Environment	2	200
RSAMD	Creation of a National Centre for Research in the Performing Arts at the RSAMD	2	300

Total: 500 (1.9%)
Total: 26,834

APPENDIX 36

Memorandum submitted by Dr Geoffrey Copeland, Chairman, Coalition of Modern Universities, Vice Chancellor, University of Westminster

On behalf of the Coalition of Modern Universities, which consists of 32 of the university institutions created in 1992 who are in membership of CVCP, I am happy to endorse the submission of the Committee of Vice Chancellors and Principals which you have already received. In addition I should like to draw the attention of the Committee to the enclosed research report, due to be published in July.[51] I note that in recent Reports the Committee has drawn attention to the need for a strategy to promote involvement with SMEs, the need for more qualified SET graduates and the role of industry in attracting graduates into industrial careers. Our research is of relevance to all these issues.

"Modern Universities and SMEs: Building Relationships" is based on a survey of 500 small and medium-sized enterprises (SMEs) in five localities. Commissioned from the Institute for Employment Research at the University of Warwick, the study was designed to:

- map the extent of interaction between SMEs and their local universities;
- explore the types of interaction in which companies were involved, and how they had been achieved;
- gauge the success of links between SMEs and the five modern universities participating in the study, and
- highlight potential areas for development in building relationships between SMEs and modern universities.

Overall, the survey data revealed that a substantial proportion of SMEs have developed beneficial relationships with their local modern university with regard to the recruitment of graduates, obtaining professional development and training, and assistance with technology and knowledge transfer relating to new product/service development and general business support. Specifically:

- *Recruitment of graduates:* is more likely where there are existing links with a university and 36 per cent of the SMEs surveyed provided placements; placements act as a way of "screening" of prospective employees and demonstrate the value of employing graduates.
- *Continuing professional development:* 22 per cent of SMEs had taken advantage of this service but there was a lack of awareness and perceived lack of need amongst the rest.
- *Knowledge and technology transfer:* 15 per cent of SMEs had benefited from this of which 5 per cent were related to technological innovation. This compares well with the DTI 1996 national survey figure of 4 per cent. These links were often the result of individual academics forging relationships.

The survey indicates that there may well be a "latent" demand from employers for the types of service that universities are well placed to serve. A number of employers reported that in the future they would like to establish a relationship with their local university but felt constrained in doing so because of a lack of information about how to develop a link.

The above finding must however be viewed in context. There are over two million SMEs and about 100 universities. The difficulties universities face in making contact with such a large number of SMEs, many of them micro enterprises, is well known; SME's often lack the personnel and expertise to engage in knowledge transfer activities.

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[51] Not printed

Although most of the activities surveyed were in place before the introduction of the new Higher Education Reach Out funding, all five universities had committed a substantial resource to building relationships with SMEs through, for example, developing "one stop" facilities that provided information, signposting, and brokerage services to businesses interested in developing a relationship with the university. Similarly, the universities surveyed had been proactive in developing networks regionally and targeting industries where they possessed expertise. With a limited resource, the universities had developed strong links with SMEs to assist their graduates obtain jobs. In addition to this, they had fostered links with SMEs relating to activities where they had a particular academic strength.

The study also points out that, when considering the role of the modern university in building relationships with SMEs it is also necessary to bear in mind the primary purpose of the university. Though there may be a strong latent demand from SMEs for a particular type of service, universities may not be best placed to meet that demand alone. Targeting of resources through intermediary organisations such as Business Links, TECs and other potential partners in the local area had proved highly successful for several of the universities in building relationships with SMEs.

I hope that this summary will encourage your members to read the rest of our report which will I trust be of interest and assistance to you in drawing up your Report.

20 June 2000

APPENDIX 37

Memorandum submitted by the Institute of Biology

1. The Institute of Biology is the independent professional body charged by Royal Charter to represent UK biology. With over 16,000 members and some 76 specialist learned biological societies affiliated to it, the Institute is well placed to respond to the above consultation on the impact of the 1993 White Paper for science. In particular, this response is jointly submitted with the following 13 Affiliated Societies: the Association of Applied Biologists, the Association of Clinical Microbiologists, the British Association for Cancer Research, the British Association for Psychopharmacology, the British Ecological Society, the British Electrophoresis Society, the British Grassland Society, British Society for Plant Pathology, the British Toxicology Society, the Freshwater Biological Association, the Institute of Trichologists, the Scottish Association for Marine Science and the Society for the Study of Fertility. One of the co-authoring Affiliated Societies, the British Association for Psychopharmacology, has also submitted comments via the UK Life Science Committee (UKLSC) which has a more molecular focus within the broad biological spectrum represented by the 76 learned biological societies affiliated to the Institute of Biology. The UKLSC has separately submitted its own response to this consultation.

SUMMARY

2. The principal points of this response are:

   (i) After the first round, there was little of particular benefit to the life science community in Technology Foresight. However, it may still be of benefit to policy-makers.

   (ii) The Council for Science and Technology (within the Office of Science & Technology) has not been as visibly active as its precursor, the Advisory Council on Science and Technology (ACOST). The role, though remains useful.

   (iii) The decline in Departmental investment in science has impeded technology transfer.

   (iv) The new Research Council mission statements with their explicit commitment to wealth creation and the quality of life may be threatening blue skies (fundamental and basic) research.

   (v) Despite the White Paper identifying the problem of short-term contracts, this issue remains one of very great concern to the biological community.

   (vi) While it is important that the UK visibly obtains value for its investment in science, there are some difficulties with the Research Assessment Exercises.

   (vii) The reorganization of the Research Councils was largely successful, but now the balance between whole-organism, molecular and systems research needs to be re-assessed so that the UK can begin to apply the new molecular sciences to whole-organisms, populations and systems.

   (viii) The creation of the Director General (DG) of the Research Councils has been largely beneficial.

   (ix) The lack of public understanding of science is in some instances impeding progress. Despite societal traits that counter science, scientists are frequently not given the time to adequately network, publish books, or engage in public understanding exercises.

(x) A subsequent White Paper might address the following issues:
- (a) the level of long-term Government investment in science;
- (b) the proportion of short-term contracts within academia;
- (c) positioning the UK to reap the benefits of the various genome projects;
- (d) the placement of science within Government for maximum benefit;
- (e) ensuring that scientists can engage in scholarship and public understanding activities;
- (f) devolution.

SPECIFIC POINTS

The headings in non-serif bold refer to the topics raised by the Select Committee on the original 1993 White Paper.

THE ANNUAL FORWARD LOOK REPORT

Forward Look is welcome

3. The annual report, Forward Look, from the Office of Science and Technology is particularly useful and is most welcome.

The 12 year retrospective, and three year forward look, is particularly useful

4. It is important that the data throughout represent a meaningful time frame. The 12 year retrospective, and three year forward look, in historical trends continues to be particularly useful in placing policy in a historical context covering a number of Parliaments. Less useful, and potentially misleading, is the two-year retrospective used in the main body of the report (the first two chapters of the 1999 edition).

TECHNOLOGY FORESIGHT (NOW FORESIGHT)

Subsequent to the first round, Foresight has generated little interest

5. Technology Foresight (now Foresight) does not appear to have been of particular benefit to the life science community. Apart from the initial Foresight round, the Institute and many of its Affiliated Societies have found that the life science community has had little or no interest in Foresight. On a number of occasions when attempting to compile responses for the various Foresight initiatives, contacting over 30 of its most active Affiliated Societies in addition to over 25 members of its science policy committees, yielded a minimal response (typically three or less). In addition, when jointly organising a Foresight workshop over 100 industries—belonging to an associate body—were contacted offering them a chance to explore Foresight concerns, not one replied.

Foresight may benefit Parliamentarians

6. However, the enthusiasm with which Foresight appears to be received from both sides of the House suggests that there is still merit in the programme. Continuing Foresight may well be of significant benefit to Parliamentarians (in summarising senior scientists' perceptions as to how science and technology will probably develop). This benefit should not be discounted, but equally not confused with enhancing a UK strategy for science.

Foresight may be unduly affecting the Science Base

7. Of some concern is that Foresight goals have become a part of applying for some research grants from the Research Councils (whose principal thrust should be in supporting more basic research[2] (both fundamental and blue skies research)). If the function of the Foresight reports is to illuminate policy (including that of technical innovation) then the principal (though not sole) brunt of Foresight-driven research should be through Government Departments and their Agencies, Regrettably, this source of funding

has seen real-term cuts over the past one and a half decades[3]: cuts which themselves have been of Select Committee concern on more than one occasion.[4] This is not to say that the Research Councils should be completely independent of Foresight, but that the balance has shifted and that current circumstances are not ideal.

ACOST AND THE COUNCIL FOR SCIENCE AND TECHNOLOGY (CST)

The CST has been less visible than ACOST. The role remains important

8. The Council for Science and Technology (within the Office of Science and Technology) has not been as visibly active as its precursor, the Advisory Council on Science and Technology (ACOST). However, the role remains an important one and is deserving of greater attention.

TECHNOLOGY TRANSFER

Despite the success of some schemes, technology transfer is comparatively weak

9. Schemes such as the Teaching Company Directorate, and LINK, have been successful. However, give the excellence of the Science Base, on the whole, technology transfer remains comparatively weak.

Departmental support for Technology Transfer has waned

10. In sub-sections on "access to science" (paragraphs 2.10–2.13) and "technology transfer" (paragraphs 2.14–2.19) of the 1993 White Paper, several references are made to the Department of Trade and Industry (DTI) as well as to other Departments (paragraph 2.19) as the bodies to facilitate technology transfer. Yet real-term investment in DTI R&D funding has declined markedly since 1992–93 despite a major boost to funding that year. Overall, Departmental R&D budgets have seen a real-term decline of some 28 per cent between 1986–87 and 1998–99. DTI R&D investment declined by over 38 per cent in real terms since Realising Our Potential and 1998–99. Notwithstanding the difficulties of technology transfer, against a background of such decline in investment it is not surprising that technology transfer has not flourished as perhaps it might.

There is concern for blue skies research within the Research Councils

11. The new Research Council mission statements with their explicit commitment to wealth creation and the quality of life may be threatening blue skies (fundamental and basic) research. The BIG breakthroughs in science do not necessarily have an immediate commercial application.

The 1993 "wealth creation" theme helped applied research

12. However, the wealth creation dimension to the 1993 White Paper was welcome in that prior to that there was a philosophy that all applied research would be paid for by industry. In reality, industry is in the main motivated to fund near-market research (if industry funds research with clear potential applications but no product, or tested market, the it may be funding research that its competitors could use). Though it is not clear whether it was this philosophy—that industry should fund all applied research—that continued the trend in decline in Departmental R&D (or whether this decline was due to managing Departmental budgets), the White Paper did help boost funding for applied research, albeit somewhat circuitously. This has undoubtedly helped with technology transfer.

The balance between blue skies and applied research needs addressing

13. Looking forward to the forthcoming White Paper, the Institute of Biology has surveyed its Affiliated Societies and is in the process of drafting a priorities document for UK biology. Though currently in its draft form[5], it should be noted that one top priority is the question of the balance between blue skies (fundamental and basic) research and applied research. It is felt that the decline of Departmental investment in R&D (and indeed the decline in synergism from the decline in Defence R&D with Civil research) has squeezed the blue skies dimension to Research Council funding. This balance should be reconsidered in conjunction with the

restoration of Departmental Funding (for which we gratefully note the Select Committee has already called[6]). We would suggest that Departmental funding be restored to its real-term mid-1980 level and there be come restoration of Defence R&D. It is worth noting that there is a logical argument for the restoration to be greater if it is based on a proportion of Gross Domestic Product (GDP) basis.

The dominance of short-term contracts do not attract those with excellence to science

14. The 1993 White paper notes, in the section on the science and engineering base, industry and Government (paragraph 3.13), the importance of excellence to industry. Further, it states that "second-rate research is a poor buy". The question then arises as to whether British science is, as a career choice, attracting those of the best calibre? Of all the concerns raised by the Affiliated Societies in the Institute's survey, that of "short-term contracts and career structure (prospects)" continues to be of major concern since our previous survey in 1997. Indeed, other than the "state and status of UK research", "short-term contracts and career structures" are currently the second most cited of Affiliated Society concerns.

Adequate assessment of industrial research lacking in the RAE

15. The 1993 White Paper also notes (again in paragraph 3.13) that it "expect[s] research relevant to industrial and other users to be taken into account by the Higher Education Funding Councils in their Research Assessment Exercises" (RAE). However, the Institute and a number of its Affiliated Societies have previously jointly expressed concerns that the RAE fails to assess properly the industrial research undertaken by universities.[7]

Scholarship activities are actively being discouraged

16. Similarly, with regard to promoting excellent scientists in the long-term, the Institute and some of its Affiliated Societies have expressed concern[8] that the drive for university income (again encouraged by the RAE) is positively discouraging scholarship activities. (Such activities include organising and attending symposia, writing text books and work with learned and professional bodies.) Indeed, we note that Cambridge University Press (CUP) in its resent evidence to the House of Lords Select Committee enquiry on "Science and Society" noted that some academics were actively discouraged from writing books. The Institute of Biology, which co-publishes texts with CUP, has also quite independently come across researchers who have been instructed not to write. Communicating, be it by writing, networking etc., is a fundamental part of technology transfer and the curtailment of scholarship activities is to be deplored.

REORGANIZATION OF THE RESEARCH COUNCILS

The rationalization of the Research Councils was most welcome

17. The 1993 White Paper's rationalization of the Research Councils was most welcome. It made sense for engineering to be combined with the physical sciences and for biotechnology to be brought into a biologically focused Research Council.

Consequently, the creation of the Biotechnology and Biological Sciences Research Council (BBSRC) was most welcome.

Molecular biological understanding now needs to be applied to whole-organisms

18. The BBSRC has been most successful in funding work that furthers our understanding of molecular and cell biology together with biotechnology. However, we now need to look forward. There is considerable concern, as revealed through the Institute's survey of Affiliated Societies, that the balance between funding molecular as opposed to whole-organism research, as well as the relevance of molecular biology to whole-organisms, populations and systems, needs to be re-assessed. This concern represents what we have called the post-genome challenge for the UK. Britain now needs to position itself to reap the gains from past and current genomic work in applying this knowledge to whole-organisms, whole-organisms and communities.

THE CREATION OF DIRECTOR GENERAL (DG) OF THE RESEARCH COUNCILS

The post of DG of the Research Councils is welcome

19. The creation of DG of the Research Councils has been largely beneficial. It provides the Research Councils with the necessary co-ordination and a champion within the OST as well as frees the Chief Scientific Advisor to focus on cross-Departmental co-ordination and advising the Government of the day.

PUBLIC UNDERSTANDING OF SCIENCE

The Institute of Biology is actively involved with public understanding

20. Echoing the 1993 White Paper (paragraphs 7.32–7.38) the Institute of Biology has long been aware of the need for public understanding of science and regularly engages in public understanding activities, including:

(i) holding public events with non-scientific organisations;

(ii) providing advice and contacts to newspapers, TV, and radio;

(iii) getting the latest science to teachers through the *Journal of Biological Education;*

(iv) organising biological contributions to cyberspace conferences (for non-scientists);

(v) providing careers information for both GCSE and "A" level pupils;

(vi) (up to 1993) maintaining a data base of speakers on biological topics which was subsequently subsumed by the DTI & COPUS's "Talking Science Data Base";

(vii) making available IoB policy offprints available to appropriate public and political meetings;

(viii) providing advice, and explaining science, to policy-makers.

Some frontier science issues do cause public concern

21. Yet despite this, together with the public understanding work of many others, since 1993 there have been a number of issues where frontier science, and its inherent uncertainty, has caused considerable public and political concern. Such issues have included: xenotransplantation, cloning, mobile phone safety, genetic modification, and climate change issues.

There are public concerns over some more established areas of science

22. There has also been public and political concerns over more established areas of science, including: food poisoning, loss of biodiversity, and antibiotic resistance.

Some non-science concerns adopt the trappings of science

23. Finally, there has been the continued promulgation of non-science using the trappings of science. For instance, the use of non-trialed alternative therapies that are referred to as "medicines" and which are available from pharmacists alongside conventional treatments, or "green" concerns couched in terms such as "environmental science" and "ecology".

Enmity, albeit from a vocal minority, is impeding some scientific progress

24. Against this background, enmity, as often expressed by a vocal minority, is impeding some scientific progress. For example, with regard to animal experimentation polls indicate that most people want testing if there are risks to human health at stake.[11] Also polls show that there are misperceptions of what and how much experimentation goes on, and, indeed, inconsistencies between declared welfare concerns and behaviour.[12] Another issue of public concern is that of genetically modified organisms. These have been used for several years for producing medicines for human consumption, but are only now of concern when used to enhance and/or preserve human food supply.

Failure to resolve the above may have considerable economic consequences for the UK

25. Such issues need to be resolved if the UK is to reap the benefit of new scientific developments such as the Human Genome Project. The economic consequences of failing to tackle this will be difficult to ignore. As per paragraph 18 above, this concern is one that the Institute's Affiliated Societies have identified as a biological priority for the UK.[13]

Scientific advice must be completely transparent and time given for proper formulation

26. There are a number of reasons causing public mistrust in science. One of these is the way scientific advice is solicited (and we welcome the Select Committee's current run of enquiries on scientific advice). Indeed the 1993 White Paper itself refers to the nation's need for scientific advice (paragraph 2.41). The public rightly expects complete transparency of advice and so all parties contributing to, or endorsing, advice should be clearly and fully cited. Advice affecting civil policy also needs to be publicly available and seen to be publicly available. Finally, scientists understandably require time in which to properly formulate a response. There are indeed, Cabinet Office Guidelines as to the way consultations should be conducted.[14] Unfortunately, transparency is not always complete, nor is there always adherence to consultation guidelines.

The RAE does not encourage scientists to engage in public understanding exercises

27. Notwithstanding the above, the time scientists can devote to public understanding exercises (or even participating in consultations) is minimal if not, in some circumstance, non-existent. Similar to the concerns raised in paragraph 16 above, the RAE does not encourage scientists to engage in public understanding of science. Indeed, the two—scholarship activities and public understanding activities—are related. Researchers through scholarship activities (through activities within academia and through learned and professional bodies) can see how their research fits into the broader landscape and so are both better placed and equipped to undertake meaningful public understanding of science exercises.

The problem of public understanding is considerable

28. Scientists actively need to be empowered to engage in public understanding exercises as the problem is a considerable one. It has been summarised by the Nobel laureate, astrophysicist, science writer and SF author Carl Sagan,[15] thus:

> "An extraterrestrial being, newly arrived on Earth—scrutinising what we mainly present to our children on television and radio and in movies, newspapers, magazines, comics and many books—might easily conclude that we are intent on teaching them murder, rape, cruelty, superstition, credulity and consumerism. We keep at it, and through constant repetition, many of them finally get it. What kind of society would we create if, instead, we drummed into them science and a sense of hope?"

For comparison purposes in 1999 the UK spent over £15.3 billion promoting just one of the above: consumerism.[16]

WAY FORWARD (SUMMARY)

A Strategy for Science

29. Having dwelt on the policies from the 1993 White Paper, it may be useful to look forward to the future and the next White Paper. This might contain a strategy for science which could include:

i. The Government's long-term investment in UK science. A return to the mid-1980s level of investment in UK science followed by subsequent growth in investment in line with the economy. In other words, the investment in UK science should be a constant proportion of the Gross Domestic Product.

ii. Regard to achieving a more equitable through-put of numbers of researchers, where ultimately recruitment in the public sector is more equal to retirement, so as to enable career structures that will attract quality students to study, hence quality graduates to embark on a scientific career.

iii. (With regard to "ii" above) the urgent need to address the question of the dominance of short-term contracts. This question was recognised in the 1993 White Paper (paragraphs 7.26–7.31) but the problem is still with us. This remains a top issue of concern to the Institute and its Affiliated Societies.

iv. Positioning the UK so that it can reap the benefits of the various (including human) genome projects. This will include policies that the UK has the right mix of skills as well as policies towards experimentation that do not unduly disadvantage the nation against competitors (see paragraphs 14 and 18). This too Institute Affiliates consider a top priority for UK biology.

v. Ensuring that science interests (currently co-ordinated by the OST within the DTI) are properly placed for maximum effect across Government and with adequate political representation at Cabinet level.

vi. Ensuring that scientists are genuinely given the opportunity to spend a proportion of their time on scholarship activities and public understanding of science.

vii. Ensuring that the UK has the appropriate science to underpin environmental and economic sustainability. Examples of areas requiring attention include: the production of new chemicals and fuels from biological sources; conserving bioresources from fisheries to the conservation of biodiversity; bioremediation; the use of biotechnology to improve productivity both of commercial processes and human beings through improved health and quality of life. "Sustainability" has been flagged as of importance by two Foresight rounds, as well as by the Institute's Affiliated Societies.

viii Ensuring that devolution does not undermine a UK strategy, specifically the UK science base. Rather, it should provide an additional dimension through the appropriate regional Departments. There will also need to be guidelines regarding the flow of scientific advice that is not solely of relevance to the devolved States.

30. The Institute and the co-authoring Affiliated Societies, in line with policy on openness, have no objection to this evidence being made public. It will shortly be available on *www.iob.org*

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[16] Advertising Association (2000) *UK ADspend breaks £15 billion barrier.* Press Release 22 May 2000.

23 June 2000

APPENDIX 38

Memorandum submitted by the Chemical Industries Association

INTRODUCTION

The Chemical Industries Association (CIA) is the major body representing the UK chemical and allied industries. The Association is also the industry's National Training Organisation (NTO) and, in conjunction with The Association of the British Pharmaceutical Industry (ABPI), runs the sector's Awarding Body for National Vocational Qualifications.

The chemical industry has always been strongly dependent upon research and technological innovation for its competitiveness, and it will need to be even more so in the future in the face of stiffening global competition. The academic science base, which provides both skilled manpower and leading-edge research expertise, is a vital resource for the industry.

The CIA thus regards this consultation to be of high importance. A comprehensive review of the extent to which the measures and objectives outlined in the 1993 White Paper have been delivered, their impact on the management and performance of science and technology, and whether the structures it specified are still appropriate, is timely.

We hope that our comments will be given the appropriate consideration since the CIA represents a sector of industry which constitutes one of the largest users and sponsors of scientific and technical research within academe. In 1997, the industry invested £2.8 billion in R&D. We estimate, based upon research performed within the CIA membership, that approximately 4.7 per cent of this investment is channeled into universities (some £132 million, annually).

We have chosen to submit comments based on the following broad themes which the consultation paper encompasses:

1. Forward Look.
2. Technology Foresight.
3. Council for Science and Technology.
4. Technology Transfer.
5. SME's and Innovation Support Programmes.
6. Research Councils.
7. Creation of the post of Director General of the Research Councils.
8. Campaign to spread understanding of science amongst school children and the public.

Our comments on all these issues are set out below.

EXECUTIVE SUMMARY

The CIA believes that perspectives in national science policy and strategy have improved as a consequence of the 1993 Science White Paper *"Realising our potential"* by:

- crystallising discussion on strategy and policy relating to science, engineering and technology (SET) within Government;
- resulting in some important initiatives such as Forward Look, Technology Foresight, technology transfer schemes, and innovation support programmes for SME's;
- ensuring that the Research Councils, especially the EPSRC, are more responsive and flexible to the needs of industry, including the demands set by the rapid pace of change in SET; and
- providing a sense of purpose to both the public and private sector on the importance of SET in a knowledge-driven economy to ensure UK competitiveness in the context of a global economy.

More specifically, we feel that:

- Forward Look should be an annual publication seeking to match Government expenditure figures on R&D and the SET base to policy objectives and the achievements (or the lack) of departmental science strategies;
- Foresight, including the "Knowledge Pool", should be properly resourced, its findings should be communicated to the wider community, and that it should be a central feature in a coherent Government strategy on the SET base;
- the Council for Science and Technology must increase its profile and transparancy, especially in industry, and stress the importance of joined-up thinking on issues facing SET across Government;
- the Government must fund more demonstrator projects, a key step in technology transfer, as well as tackle barriers such as the Research Assessment Exercise which can hinder collaboration between industry and academe;
- the myriad of Government funded research and innovation support schemes, not funding levels, for both SME's and academe should be reduced to a select few. The Government should also ensure that innovation policy does not become too pre-occupied with SME's, thereby ignoring the needs of their larger industrial counterparts;
- the Research Councils should continue to be more receptive to the needs of industry, embrace a closer working relationship with each other, and promote career progression for fixed-term research staff as well as increase the funds allocated to PhD students;
- the appointment of the Director General of the Research Councils has helped to co-ordinate their activities, thereby ensuring that their approach is synergistic, strategic, visionary and cost effective;
- the Government must re-direct its efforts to helping improve the perceptions of the risks associated with science rather than focusing soley on the public understanding of science. Its current campaign to spread the understanding of science has had little, if any, positive impact in society;
- the Government must continue to invest in the science base, increase public expenditure on R&D activities—the current decline should be reversed, and improve the reward and remuneration structure associated with a scientific and a teaching career;
- the Government must ensure that the forthcoming White Paper on "Science and Innovation Strategy" is holistic, promoting strategies and policies which are practical, and readily achievable.

1. Forward Look

The annual publication of Forward Look has developed significantly since its inception, and it provides an excellent synopsis of Government's strategies for science, engineering and technology.

The statistical summaries of various Government departmental budgets have proven to be particularly useful in influencing the key objectives of science policy across Government, and we support its continuance as an annual publication. However, Forward Look should seek to match expenditure figures more specifically to policy objectives and the achievement (or the lack) of departmental science strategies.

Finally, we welcome and agree with the conclusions and recommendations made by the recent House of Common Science and Technology Committee's report on "Government Expenditure on Research and Development: The Forward Look", published on 19th April 2000.

2. Technology Foresight

The creation of Technology Foresight (now Foresight) is an important development arising from the 1993 White Paper since:

- it offers an unrivalled networking opportunity, thereby helping to improve communication, interaction and mutual understanding between Government, industry and academa;
- it has served as an excellent platform for participants to think constructively, critically and imaginatively about future economic, social and technological implications and challenges;
- it has been an important catalyst for many companies in the chemicals industry to evaluate and enhance their industrial R&D priorities, and to influence and initiate change in their business strategies, by developing strategic vision through the use of the outputs from the 1st Foresight round.

Although the CIA enthusiastically supports Foresight, and we remain committed to its principles, there are a number of issues which are of concern to us. These include:

- a large proportion of individuals, especially from academe, have either never heard of Foresight or have never been exposed to its outputs due to the lack of dissemination of information from the 1st Foresight round;
- many small and medium enterprises (SME) have not directly benefited from Foresight since the majority tend to do little, if any, long-term strategic planning;
- there is still an immense scepticism about the value of Foresight due to the lack of persuasive evidence of the benefits associated with it since many of them tend to be intangible.

Foresight is extremely effective in identifying opportunities and threats but it has yet to galvanise the efforts required to arrive at solutions to any problems identified.

- there is a general perception that Government departments still do not consider themselves to be one of the principal audiences for Foresight, especially in the analysis of issues, and in the subsequent delivery and implementation of policy from a practical perspective;
- there is little evidence of developing coherence in science and innovation policy across Government as a consequence of the Foresight programmes. However, we hope that the forthcoming Science and Innovation White Paper will help resolve this matter.

On a more positive note, the recommendations from the 1st round of Foresight have been used by the Research Councils to help shape their programmes, and we hope that this will continue;

- the current round of Foresight is almost invisible, and the much publicised "Knowledge Pool" has yet to deliver any tangible rewards.
- One of the reasons behind this is the lack of proper resources and variable support given to Foresight by the Office of Science and Technology. We believe that without greater Government commitment, the present round of Foresight will not realise its full potential.
- Foresight also needs to be more targeted rather than "all encompassing" with the result that it may cover nothing adequately.

Overall, we believe that Foresight should be a central feature in a coherent Government strategy on science engineering and technology (SET), influencing government policy on issues such as expenditure of the science budget, and promoting the progress of the SET base.

3. Council for Science and Technology

We do not feel competent enough to comment on the wisdom of abolishing the Advisory Council on Science and Technology and replacing it with the Council for Science and Technology (CST). However, its successor has appeared to be largely invisible since its inception. Although, we are unable to comment on the impact of its activities on influencing Government's own research spending, we note with some concern that this is sadly in decline.

We believe that a body like the CST does have an important role to play in the strategic overview of science and innovation issues, but it must be more transparent in its activities. Recent Government initiatives have delivered a framework of policies promoting innovation, but any advisory body on science and innovation strategy must stress:

- the importance of joined-up thinking across Government;
- raise the general awareness of the importance of research and innovation in the context of a global economy;
- promote an effective and supportive taxation regime for R&D activities;
- ensure that legislation promoting R&D, not hindering it, is created such as a strong patent regime.

4. Technology Transfer Initiatives

We welcome the Government's desire for supporting technology transfer initiatives between the science and engineering base and industry, and we believe that this is an extremely important activity in the knowledge-driven economy, and for UK competitiveness.

However, and worryingly, the proposed interchange of ideas, skills, know-how and knowledge has yet to fully materialise. Although the Research Councils have encouraged greater industrial involvement in their projects, LINK has been maintained and bodies like the Institute of Applied Catalysis have been created, these form only a very small microcosm of ventures which are needed to help improve industry and academe collaborations.

To date, many powerful barriers exist which still tend to prevent the desired change in attitudes to collaboration. These include:

- the Research Assessment Exercise;
- the reluctance of acadame to work in an interdisciplinary manner;
- the attitude of some Industrial Liaison Officers;
- the lack of appreciation of intellectual property rights by academe;
- the lack of funds to undertake demonstrator projects which often are a key step in technology transfer.

The recent initiative entitled "Higher Education Reach Out to Business and the Community (HEROBIC) is a welcome experiment on promoting technology transfer. However, funds allocated to it are very limited. We believe that these types of schemes should be actively pursued and properly funded by government, especially when they can be strategically integrated with other collaborative links promoted by different government departments.

Although, the 1993 White Paper has created the momentum to explore new approaches to knowledge transfer, more needs to be done to ensure successful integration of novel and "blue sky" ideas from academe into industry by:

- Increased but targeted funding for science parks.
- More technology incubator programmes.
- Emphasising the importance of developing relationships between established innovative firms and academe, and not just focusing on spin-offs from academe.
- Promoting diversity and creativity in the workforce (by encouraging greater recruitment from outside the UK—either from Europe or elsewhere).
- Emulating the successful US-based Small Business Innovation Grants Scheme.

Overall, the conversion of technologies and ideas, emanating from the UK science base, into innovative products and processes, are vital for the future success of the chemicals and allied industries in the UK.

5. SMEs and Innovation Support Programmes

The Government has made significant progress on improving the access for small and medium-sized enterprises to innovation support programmes. For example, the Specialised Organic Chemicals Sector Association (SOCSA), which was created in 1993 as a part of the CIA, has definitely benefited from some of these initiatives. It has been able to access funds for projects in areas of pre-competitive, under-pinning science such as applied catalysis, process engineering and analytical science.

Furthermore, the recently announced tax incentives for SME's to undertake R&D are a positive sign of the Government's commitment to help companies invest in innovation, and this is warmly welcomed by the CIA. However, much more needs to be done in this area and the Government must not be complacent. In addition, we still have a number of concerns relating to innovation support programmes, and these are:

- The myriad of Government schemes, which are currently in operation, on supporting research and innovation for SME's (and within academe), needs to rationalised to a select few. We believe that a reduction in the number of initiatives (not the funding levels) is warranted.
- Innovation policy can become too pre-occupied with SME's and start-up companies, and therefore ignores the needs of their larger industrial counterparts. Many of these now tend to operate as small business units, and play an important role in the knowledge-driven economy. The emphasis purely on SME's can also lead to some confusion in the objectives of innovation and employment policy.
- The lack of access to academe is still cited as a major issue for SME's within the chemicals sector, although SOCSA has provided some help in this endeavour.

Overall, we believe the 1993 White Paper has had a positive impact in ensuring that the Government understands the needs of SME's, especially from economic, regulatory and social perspectives.

6. Research Councils

The re-organisation of the Research Councils with modified management structures, as a consequence of the 1993 White Paper, has been broadly positive.

The current move towards encouraging interdisciplinarity, greater co-ordination between the Research Councils on related activities, alignment of projects with those of the findings of Foresight, the creation of peer review pools, recognising the importance of consulting the wider community (in particular industry) on their research needs before embarking on specific and targeted programmes, and their increased enthusiasm to collaborate with industry, are to be applauded.

However, there are still a number of issues which need to be resolved. These are:

- Each of the different Research Councils tend to operate via their own criteria and *modus operandi.* For example, the EPSRC dispenses industrial CASE awards whilst with the BBSRC you have to bid for them.
- We believe that a commonality of approach should be implemented across all the Research Councils as soon as possible.
- It is vital to ensure that a correct balance is struck between the managed and responsive mode funding mechanisms.
- The continuing difficulties in providing career progression for fixed-term research staff and post-doctoral research workers, and properly funding PhD students needs to be assessed and positive solutions developed.
- In this regard, we welcome EPSRC's proposal or greater flexibility in support of doctoral-level training, and we hope that they will develop flexible funding schemes to support young researchers early on their scientific careers in academe.

Overall, we feel that the changes which have been undertaken by the Research Councils, especially the EPSRC, will help to promote wealth creation and improve the quality of life in the United Kingdom. We certainly look forward to working more closely with them in the future since their outputs, both in terms of trained scientists/engineers and research projects, are extremely vital to the success of the UK chemicals industry.

7. Creation of the post of Director General of the Research Councils

We welcome the creation of the post of the Director General of the Research Councils and the absorption of the functions of the Advisory Board of the Research Councils into the Office of Science and Technology.

This has been an essential appointment to help co-ordinate the activities of all the Research Councils, thereby ensuring that that their approach is synergistic, strategic, visionary and cost effective. We believe that it is vital that the post-holder should be an individual with solid industrial experience who has an appreciation of the importance of pure and applied research to industry and an understanding of the needs of academe.

8. Campaign to Spread Understanding of Science Amongst School Children and the Public

Understanding of Science: the general public

The launch of a campaign to spread the understanding of science has had little, if any, positive impact amongst the public-at-large. Our own surveys, conducted by MORI, suggests that it is trust and perceptions of risks rather than public understanding of science that are the real issues to address. In our surveys, there is no positive correlation between a formal science education and favourability towards the chemicals industry.

We feel that one possible reason may be that policy makers and scientists are often wrong in the predilection for promoting a desired message rather than engaging the public in scientifically informed debate. Their messages should be tailored to combating their genuine concerns and lack of understanding of science.

We recognise that this is a complex issue, whereby any gains made in developing a trust in and acceptance of science can be easily lost if the community-at-large feels underestimated, threatened or coerced. Therefore, we support the view that it is the responsibility of scientists, in academe/government/industry—in both the public and private sectors—to work together in order to re-establish public trust, enunciate the benefits and discuss potential concerns derived from research and development activities in an impartial and honest manner.

The chemicals sector is certainly keen to complement the work of Government and academe to promote science, including its importance to society, by engaging in debate with NGO's and other stakeholders of the role of chemicals, the chemicals industry, and of science in general, in an informed and sensitive manner.

Understanding of Science: school children

We strongly believe that science should remain an essential element of the national curriculum at both primary and secondary level so that school children can have some appreciation of its importance in the modern world.

The Dual Science GCSE (DSG) can play an important role in influencing the up-take of science at A-level by young students. A negative experience of DSG can easily discourage pupils from undertaking science at higher level. We are also concerned about the value of DSG as an effective preparatory tool for those who wish to study natural sciences at A-level. We feel that the Government should examine its worth compared to the merits of studying individual science subjects separately at GCSE.

Young individuals who train as scientists and engineers are the key to the future vision of a knowledge-driven economy in the UK, and although, we applaud the various Government schemes relating to improving science education, there are significant and fundamental challenges which still need to be addressed. These include:

- the poor reward and remuneration associated with a scientific and a teaching career;
- the lack of infrastructure investments at both schools and universities;
- the general view that science has no future in the UK.

The lack of up-take of science courses can also be attributed to these issues. We believe that it is vital for both government and industry to work together in tackling these areas of concern.

General Comments

The wider public appreciation and understanding of science has probably been the least successful aspect of the 1993 White Paper. The image of science still remains poor, further damaged by the BSE crisis, the GMO issue and other reports in the press which have dented the public trust in it. The campaign to promote science amongst school children and the public (for example, through Science Week, and the work of the British Association) also seems to have passed unnoticed.

We recognise that many organisations are making valuable contributions in this area, but we feel that there needs to be much greater cohesion of the activities in order to make a significant impact. The Government has a clear role here by continuing to publicise the benefits of science, working with all concerned parties for greater critical mass and to ensure that science and engineering are in the hearts and minds of the public in a positive light.

Finally, we would like to add that the recent House of Lords Science and Technology Committtee Report on "Science and Society", published on 14 March 2000, makes some excellent recommendations which we would support. We hope that the Government will act on its findings, especially those relating to the need for an open and impartial public debate on the role of science within society. We also believe that the Higher Education Funding Councils should give serious and urgent thought to rewarding work performed in improving the public understanding of science.

Closing Remarks

The 1993 Science White Paper represents an important milestone in acknowledging the importance of the science base; crystallising discussion on strategy and policy relating to SET expenditure within Government; and providing a sense of purpose to both the public and private sector on the importance of science in a knowledge-driven economy.

We believe that perspectives in national science policy and strategy have improved as a consequence of the 1993 White Paper. For example,

- the Research Councils are more receptive to the needs of industry;
- the 1st round of Foresight did help to identify the importance of partnerships between industry an academe;
- evaluation and the impact of R&D activities has now become the norm;
- scientists are more ready to acknowledge and address public expectations/concerns of science issues, as well as countering the effect of negative reporting by the media on the SET base;
- concerns (and action needed) are openly expressed about the decline in public funding of research and development, including the decay in research infrastructure, employer difficulties in recruitment and retention of scientists and the complexities faced in undertaking collaborative ventures with academe.

However, although the progress made to-date is highly welcome, and the themes of the 1993 White Paper are currently valid, a great deal of work still needs to be done. We hope that the forthcoming White Paper on "Science and Innovation Strategy", the broad aims of which the CIA fully supports, will try and address some of the issues and concerns which have been identified as a result of the 1993 White Paper. A copy of the CIA's submission to the DTI's recent consultation on Science and Innovation Strategy is attached for your information.[52]

We strongly feel that the new White Paper must present a clear direction, understanding and vision of the UK's national needs; ensure adequate and long-term funding for the SET base; and promote and foster a climate where innovation, entrepreneurship and risk taking is supported and encouraged. In particular, we believe that the Government should:

- take a more holistic view of innovation, if it is to make any real impact on the UK economy, just like the Japanese have done so successfully. For example, the marketing of R&D activities is a key function for generating profits from innovative products and processes, and it is this that tends to be lacking in the United Kingdom;
- Furthermore, if the UK is still going to retain a strong chemicals manufacturing base, then innovation in process technology is as important as investment in new products;
- avoid generating false expectations that have resulted from earlier science policy, and we look forward to seeing more details in the forthcoming White Paper as to how their ambitious plans will be translated into both policy and action;
- improving the current and poor image of the SET base, which is exacerbated by the City's and media's obsession with companies who are part of the "new" economy, namely the dot-coms. "Old" but robust and financially strong industries, such as those in the chemical sector, are no longer fashionable and perhaps even deemed uncompetitive in comparison to their new counterparts.

In conclusion, a strong science base is vital for the UK to continue to be innovative. Stimulating knowledge transfer schemes, improving the flow of skilled scientists and engineers into industry is fine, but this only addresses a small part of the overall jigsaw which needs to be examined.

The UK still retains a high quality science base, world class in many areas, in spite of government funding which is poor in relation to our major competitor nations. If government support for scientific and technical research is not improved, through better strategic focus and an overall increase in spend, the UK will lose its position as an attractive base for research-intensive industry, with severe implications for prosperity and employment in the future.

We hope that we have identified some of the issues which the consultation needs to take into consideration and address. Through its Science, Education and Technology Committee (SETCOM) the CIA and its member companies welcomes this opportunity to work closely with the House of Commons Science and Technology Committee so that the SET base in the United Kingdom can be strengthened, for the benefit of government, industry and academe.

July 2000

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[52] *Not printed.*

APPENDIX 39

Memorandum submitted by the Association of the British Pharmaceutical Industry (ABPI)

INTRODUCTION

1. The Association of the British Pharmaceutical Industry (ABPI) represents the majority of the companies in Britain engaged in the research, development, manufacturing and supply of prescription medicines. The ABPI brings together companies producing such medicines, whether branded or generic, many smaller organisations involved in pharmaceutical and biopharmaceutical R&D, and those with an interest in the pharmaceutical industry operating in the UK. ABPI member companies manufacture and supply more than 80 per cent of the medicines prescribed through the NHS and are major exporters to countries all over the world.

2. Six out of the world's top 25 medicines were discovered and developed in British laboratories. As a result, patients in the UK benefit from the early introduction of new medicines here.

3. The industry's long history of pharmaceutical innovation is supported by intensive research activity. The vast majority of medicines research carried out in the UK is funded by the pharmaceutical industry and most of the major global pharmaceutical companies have established research and manufacturing bases in this country. As a result, the industry is an important employer, with around 60,000 people employed directly and many more in feeder industries. The industry invested £2.7 billion in R&D in 1999—more than £7 million every day.

4. The strengths of the pharmaceutical industry's R&D activities in the UK are dependent upon the quality of the graduates and postgraduates arising from the countries; universities. The industry's confirmed investment in the UK has also long been dependent upon the quality of the research carried out in the universities, research institutes and clinical centres here, with many of which collaborative arrangements have long been established.

GENERAL COMMENTS

5. In view of the importance of the UK Science Base to the pharmaceutical industry, the ABPI and its member companies saw the introduction of the 1993 White Paper as a major development.

6. ABPI considered at the time that the 1993 White Paper was seminal in placing science on the Government agenda in a serious way. No other initiatives in the previous two decades had attempted to address the many issues related to the academic science base, education and industrial needs and opportunities. The ABPI believed that the then Chancellor of the Duchy of Lancaster, William Waldegrave, and the Chief Scientific Officer, William Stewart, were an excellent team who created enough energy to conceive and implement this White Paper.

7. One of the key outcomes of the White Paper was the Technology Foresight initiative which, as Foresight, has just come to the end of another round of consultation. The ABPI was actively involved in the early discussions on Foresight as an exemplar of good practice, an industry with a strong research base, high productivity and a substantial contribution to the Nation's balance of payments. The industry participated in many of the Foresight Taskforces and was widely involved in the Foresight process, particularly on the Chemicals and Health Care Panels.

SPECIFIC COMMENTS

The extent to which the industry believes that the objectives set out in the 1993 White Paper "Realising our Potential" has been delivered

8. ABPI believes that in the main, the objectives of the 1993 White Paper were met.

9. In particular, the profile of science and scientists was raised across the nation in academia, Government establishments, industry and the investment community and with the public. The take-up was variable, of course, but there were many good initiatives, including Foresight and the SET programmes. It was particularly important that the White Paper allowed more effective access to Government, and its agencies, by scientists, initially through the Duchy of Lancaster and subsequently through the DTI.

10. There was more transparency on the budgetary aspects of the science base, particularly over a longer time frame through the Forward Look documents and the dialogue created around them.

11. The restructured Research Councils and the appointment of the Director General of Research Councils were seen as successful and positive moves to relate the funding of research more closely to its community. The operation of the main Research Councils, EPSRC, BBSRC, MRC, and ESRC remain generally effective. Issues concerning the interface between the formal remits of the Councils, as in life sciences research, do continue to arise, but are generally handled well.

12. The Science Base still requires a significant improvement in infrastructure, particularly in its academic elements. It must be acknowledged, however, that substantial efforts have been made through the recent infrastructural funding initiative. A longer-term programme of investment is, however, needed.

13. The public is still uncomfortable with some elements of science and its products. A number of the major issues over the last five years, eg BST, GMOs, cloning etc, have made this worse. Although the SET weeks and other initiatives have in themselves been successful, it is disappointing the public at large remains deeply suspicious of science, particularly when it is conducted in industry. The ABPI and its member companies have active programmes in promoting the benefits of their research, but more can and should be done. To increase public awareness of science requires, we believe, more innovative thought and resource. Greater transparency in the handling of scientific issues by Government is also needed.

14. The 1993 White Paper was necessarily pan-sectoral although Technology Foresight did try to address specific sectoral interests, e.g chemicals, pharmaceuticals etc. The pharmaceutical industry was seen as an excellent example of industry in tune with its science base, and was often quoted as "best practice". As a result, unfortunately, it may have subsequently been less favoured with initiatives, a casualty of its own success.

Technology Foresight was an excellent strategic tool but perhaps was used too early in tactical funding decisions on an annual basis. Foresight was intended to look 10–20 years into the future.

15. Govermental efforts then and now are motivated towards increasing the number of spin-out, start-up companies. Whilst the growth of the SME biotech community is to be welcomed, the need for sustainability must be considered. In the long-term, high-risk, pharmaceutical and biopharmaceutical sectors, there was, has been and still is a lack of adequate funding at the second stage of development of companies. It is at this stage (where ideas, which have been reduced to practice and taken on into development) that there is a shortage of resourcing. Companies at this stage require money in the £2-5 million bracket rather than the £0.2-5 million needed for seed corn investment.

16. The reorganised Research Councils took a long time to address interface areas of science, many of which are of substantial interest to the industry, notably biomolecular sciences, pharmaceutical sciences and materials science in the biological arena. This is an aspect that the DGRC is undoubtedly aware of, but the barriers to progress remains a matter for concern in the user community. At the same time, co-ordinating major initiatives, for example, linking electronic patient records and SNP databases, remains a difficult issue that appears only able to be tackled at Governmental level.

Whether the objectives and themes of the 1993 White Paper remain appropriate to the development of a strategy for science, engineering and technology and, if not, what other themes and objectives would be more beneficial.

17. THE ABPI CONSIDERS THAT THE OBJECTIVES AND THEMES DESCRIBED IN THE 1993 WHITE PAPER SEEMED APPROPRIATE AND ARE STILL BROADLY RELEVANT.

New areas of particular interest to the pharmaceutical industry relate to the increase in partnership structures between companies themselves and between the industry and academia. There is also a growing increase of "contracted out research" outside perceived core areas of expertise in companies. This suggests that flexibility and inter-disciplinarity should be key elements in any new themes and that sectoral difference should be recognised.

Whether attempts to deliver the proposals of the 1993 White Paper have resulted in a culture change across, or in parts of, the science, engineering and technology base and, if so, what is the nature of this change and how has it been demonstrated?

18. The proposals of the 1993 White Paper attempted to induce a cultural change across the UK's science base. Although the industry has been going through major changes since the publication of the White Paper, the ABPI believes that few cultural changes have occurred in the industry as a result of the White Paper. There have, however, been substantial changes in the interactions between the Research Councils and industry, which are welcomed and hopefully will be further developed over time.

The Government's recent consultation on Science and Innovation Strategy stated that "the aim is to use the UK's excellence in science to achieve improvements in our national innovation performance and so to improve the competitiveness of the economy and the quality of everyone's life" and indicated its plans to achieve this by:

- sustaining the excellence of the science and technology base
- encouraging private investment in innovation
- streamlining knowledge transfer schemes and focussing them on clear goals
- fostering regional networks
- improving the flow of skilled scientists and engineers to industry
- improving the ability of the science base to play a role in the knowledge economy
- taking advantage of the globalisation of research, and
- improving public confidence by creating greater transparency in the regulation of science.

Do we Agree that these are Appropriate Aims for a National Strategy for Science

19. The Government's recent consultation on Science and Innovation Strategy, which sought to use the UKs excellence in the science base to achieve improvements in our national innovation performance, was timely and useful.

20. ABPI supports the goal of sustained excellence in the academic Science Base but feels that the key issues of selection and directed funding to Centres of Excellence in research has not been addressed.

We have long argued that limited resources, available in the UK for funding research, cannot be applied across more than 100 universities in the expectation that excellence will be developed or sustained. We welcomed the commitment given in the White Paper to continuing support for dual-funding and continue to believe that this is important if truly innovative new science is to be carried out. It has long been clear, however, that the dual-funding system is under-resourced. Though selectivity of resource allocation is essential, we accept that it carries with it the danger of stifling the unexpected and preventing the emergence of new centres of excellence: dual-funding provides an essential mechanism to allow new fields to become established.

21. We also feel that the arrangements for the training of postgraduate scientists (policy 12 in 1.18 of the White Paper) still leave room for improvement and there is still a serious problem in the career track for professional young scientists.

22. Encouraging private investment in innovation differs between sectors and the biotechnology sector/industry has been extremely volatile of late. We accept that there is an inadequate amount of second stage funding available for those start-ups recently established in the UK. At the same time, the present trend towards consolidation by SMEs may have mixed results. Certainly some companies are being encouraged into partnerships that may not be in the long term interests of the prospective partners but the result does allow exits for investors.

23. Knowledge transfer is a key driver for the pharmaceutical industry but its transfer needs are probably different to the needs in other sectors and a sensitive approach is needed to this area.

24. There is clearly a major opportunity within the SME sector of the pharmaceutical/biopharmaceutical industry in the provision of regional support networks. SMEs need access to such support but can rarely make time to attend discussion or help groups which appear to be centred in London, Edinburgh or Cardiff. Increasing the tailored support for SME needs locally would be a great help along with an awareness programme and seamless contact points.

25. The supply of skilled postgraduate and postdoctoral scientists to industry remains vitally important. The industry will, however, always look for the "Quality" descriptor in such supply chains and indeed would be happy to work with academia in their supply. The ABPI continues to have discussions with Learned and Professional Societies to seek their perspective on this issue and to promote current industry thinking. It is important that the infrastructure to support the training needs for the industry is well maintained.

26. In our industry the science base is integral in our knowledge economy—indeed it is integrated throughout the whole supply chain from discovery through development to manufacture and sales. We are a global industry and try to seek appropriate support through tax incentives, effective but not excessive regulatory processes, a minimal bureaucracy consonant with effective business procedures and a general supportive environment. We do recognise that the needs of SMEs mid-range and "big" pharma may differ and try to participate in discussions with other representative organisations to achieve a balanced solution.

ABPI and its member companies tries locally and nationally to build public confidence by creating greater transparency in the regulation of science. We do not believe the answer lies in the greater regulation of science.

What do we believe should be the main features of a modern strategy for science, engineering and technology, and why?

27. A modern strategy for science, engineering and technology must be open, interactive, and be embedded in both government and industrial cultures. The ABPI is committed to work with all parties to achieve this. That the Government is again preparing a White Paper on Science and Innovation is a welcome sign that the importance of science to the UK economy is fully appreciated. If the forthcoming White Paper is as effective in stimulating awareness as was "Realising our Potential" in 1993 then it will be an important and influential document.

July 2000

APPENDIX 40

Memorandum submitted by the Economic and Social Research Council

INTRODUCTION AND SUMMARY

1. The ESRC welcomes the opportunity to contribute to the House of Commons Select Committee Inquiry into the impact of the 1993 White Paper on Science, Engineering and Technology. Given the Government's preparation for the forthcoming White Paper on Science and Innovation, it appears particularly timely to learn lessons from the last major structural change following the 1993 White Paper.

2. As the leading public funding agency in the UK for the support of research and postgraduate training in the social sciences, Economic and Social Research Council has a central contribution to the national science base and the wider public good. The reason for this, in part, is attributable to the response that the Council has made to the 1993 White Paper, which includes:

- strategic aims and plans to deliver the objectives of the White Paper and ESRC's new mission;
- regular national consultation with the public and users on ESRC's *"Thematic Priorities"*—which have guided ESRC's funding decisions on research and training since 1995;
- users involved at all levels of ESRC's decision-making;
- communication strategies for all research programmes; the creation of networks of users, and user engagement plans for all research awards;
- engagement with White Paper initiatives such as Foresight and ROPA awards;
- concordats with major Government Departments and agencies;
- collaboration with other Research Councils and private and public sector bodies;
- development of major initiatives to increase take-up of ERSC funded research in public and private sectors;
- increased administrative efficiency and effectiveness.

3. More generally, we believe the changes in culture and focus that were promoted by the White Paper are being addressed and consolidated in publicly funded research. There is increasing openness and transparency in the Research Councils, and more effort and expectation in achieving knowledge exchange and use of research outcomes in policy and commercial settings. Social scientists work closely with users to increase both the quality of the research and its impact in applied settings.

4. However, there are a number of issues concerning the White Paper that need further consideration.

The early focus on economic competitiveness at the expense of quality of life issues has not been entirely resolved; this has implications for the contribution of the arts and humanities to the objectives of the White Paper, as well as for the social sciences generally.

The increasing involvement of users in the business of the Research Councils has not necessarily led to greater public acceptance or confidence in science; it is possible that it has had the opposite effect.

The "Haldane Principle" which clearly separates scientific and governmental decision-making processes has become less clearly defined. This may also have contributed to a loss of public confidence, and needs to be restated in the modern context.

The Funding Councils' allocation for research through the Research Assessment Exercise remains largely incompatible with realising the White Paper objectives for publicly funded research. The RAE's strictly academic incentives for scientific research encourage discipline oriented journal output rather than longer-term contribution crossing discipline and academic/user boundaries.

Research careers remain insecure and underpaid despite the concordat. This is detrimental to research in the UK and to achieving the aims of the White Paper. We would recommend that this issue is addressed in the Inquiry.

5. This memorandum continues in three parts. The first part contains a general overview of the strategic and operational measures that ESRC implemented following the White Paper, and the second part addresses the specific issues raised by the Select Committee's Inquiry. There is a brief concluding section at the end.

ESRC Response to the 1993 White Paper

Strategic Planning

6. The White Paper led the ESRC to embrace the three core elements of *Quality, Relevance and Independence* to characterise its distinctiveness as a research funding agency, and the value it adds to public investment in research. All three are key attributes to fulfilling its purpose, but the most important is quality—ensured through peer review of all ESRC's research, without which the contribution of research to basic or applied areas would not be effective. *Relevance* is achieved through our Thematic Priorities, and *Independence* enshrined in ESRC's charter.

The Council introduced four long-term strategic aims in response to the White Paper:

(i) *Investing in Themes.* The Thematic Priorities enable the ESRC to operate effectively at the intersection of the interests of academia, public policy, business and industry, and to engage with initiatives such as the Foresight Programme. The themes are identified through national consultations undertaken every three years and involving all our constituencies. The themes therefore allow ESRC to address the most pressing scientific and national priorities by providing the framework to guide the decisions of the Council and its Boards on funding research and training. There are currently nine Thematic Priorities (which are available on the ESRC website), with about 65 per cent of ESRC's budget allocated to them, mainly on research programmes and centres. The Council has just completed its Year 2000 Review of the themes. A set of new or modified themes will be published in the autumn and will guide ESRC for the next three years. In the context of the Select Committee's Inquiry, one important finding of the consultation was the extent to which the thematic approach has now become accepted and understood in the academic and user communities.

(ii) *Developing Social Science.* This aim concerns the Council's commitment to develop and promote social science research capacity in the UK to undertake research of the highest quality. Activities in support of this aim include responsive mode research grants, research resource provision and postgraduate training.

(iii) *Working with Users.* The Council, aiming to work with users to increase the relevance and impact of its activities, sought and succeeded in engaging users and stakeholders at all levels of Council business. Council itself consists of 50 per cent academics and 50 per cent drawn from the private, public and voluntary sectors. There is strong user presence on Councils boards and committees, and users and stakeholders are centrally engaged in research programme development, commissioning and evaluation, and in research communication. These activities, which involve users in agenda and priority setting, in selection of research and management of its output, mark a move away from the linear model of research output flowing to users through dissemination of material.

The full extent of collaboration with external constituencies on specific ESRC programmes and schemes can be seen from the attached Annex 1, which is taken from the 1999–2000 ESRC Operating Plan. In addition, ESRC has eight concordats with central Government Departments and the devolved administrations of Scotland and Wales. We have recently developed "connect"—a forum for communicating ESRC research to private sector organisations.

(iv) *Managing our Resources.* The Council has continued since the White Paper to address the efficiency and effectiveness of its activities. Staff numbers have been reduced by around 20 per cent, while at the same time workload and the range of activities has significantly increased (both directly and indirectly as a result of the White Paper), and the budget itself has increased by 20 per cent. This has led to considerable pressure on the staff of ESRC.

7. These four aims provide the structure for ESRC's strategic and operational plans, and enables the Council to monitor the extent to which the White Paper objectives are being achieved.

ESRC Response to Issues Raised by Select Committee

Extent to which the objectives set out in the 1993 White Paper, Realising Our Potential, have been delivered.

Objective1: Forward Look

8. The Forward Look is useful in outlining and clarifying the priorities for science and technology across Government as a whole. The format and structure of the Forward Look has improved significantly and may well provide a helpful information source.

Objective 2: Technology Foresight/Foresight

9. It is now widely acknowledged that the value of the first Technology Foresight exercise was limited by the lack of social and economic perspectives in the work of the sector panels. Consequently the recommendations of this exercise did not accurately reflect important projections in such areas as the changing demographic composition of the UK (and Europe), changing lifestyles and consumer behaviour, or economic trends inherent in globalisation. The ESRC's Thematic Priorities sought to incorporate the findings of the exercise, however, and we also collaborated on specific Foresight related projects through the "Foresight Challenge" programme.

10. The current Foresight Programme, reflecting the views of many participants in the first exercise (including ESRC) has incorporated social and economic perspectives both in terms of the panel coverage and methods (eg the knowledge pool). Thus, for instance, there are panels on Ageing, Crime and Education, and social scientists are involved as contributors, participants and advisers to panels. We are more hopeful that the outcome of the current programme will have, in marked contrast to the first, longer-term social horizons, and greater impact as a consequence.

Objective 3: Council for Science and Technology

11. The role of the Council for Science and Technology and its relationship to other elements within the Office of Science and Technology are unclear. It may provide the independent advice that was originally intended, but this is not widely apparent. This would suggest the need for a wider communication of the Council's work.

Objective 4: Technology Transfer

12. The ESRC has welcomed the shift to place more importance on the interchange of ideas and knowledge between scientists and users, and has itself made significant changes in its decision process to address this policy. The wider interpretation of knowledge transfer is even more important with the rapid expansion of new media and information technologies as tools of the knowledge based society and economy.

13. However, one consequence of the technology transfer debate has been an inappropriate emphasis on the division between basic and applied research, and an apparent confusion of the roles of research funders. Public investment through the science vote alone is not sufficient to address the needs of private or public sector users—and nor should it be. The academic community and the funds it receives from the Research Councils are only one part of the equation.

14. This suggests that policies and incentive measures for public and private sector R & D need to be considered and applied through other Government policy mechanisms, such as fiscal policy and industrial policy. Thus it would be a mistake in our view, for the Government's Science and Innovation Strategy to place the greater burden for innovation on the Research Councils.

15. On a specific level the ESRC collaborates directly through LINK, CASE and TCS (formerly known as the Teaching Company Scheme). The ESRC has funded major research programmes and centres on innovation which have involved building very close links with the private sector. The Council is currently establishing a major new resource in evidence-based policy, which aims to bring the findings of the highest quality social science research in the UK further into the domain of those who need to use it. Many of our leading researchers are engaged in the development of key policies, working closely with policy-makers. The ESRC is also currently implementing a programme to evaluate the impact of our research in the public and private sectors.

Objective 5: Improve SME access to innovation support programmes

16. The White Paper has had an impact on improving the partnership between research and SMEs through LINK, CASE and in particular the TCS which has played an important role. In 1999–2000, 87 per cent of new TCS Programmes with ESRC funding involved SMEs.

Objective 6: Re-organisation of the research councils

17. Paragraph 6 illustrates the range of approaches and measures introduced by ESRC in response to the 1993 White paper. This was accompanied by measures to manage resources through reduction in staff numbers, re-structuring of divisions, and new and flatter management and grading structures.

18. These internal changes were part of a wider structural change of the Research Councils and the creation of the Office of Science and Technology, which itself was eventually re-located into the Department of Trade and Industry. With regard to the current make up and boundaries of the Research Councils, we believe the system has worked well, enabling the development of collaborative ventures between the Councils and the promotion of multidisciplinary research. However, the arts and humanities also have a key role to play in addressing the White Paper objectives but have remained outside the Research Council system. The Inquiry should include the future of the arts and humanities in its considerations.

Objective 7: Creation of DGRC and abolition of ABRC

19. The creation of both the post of Director General of the Research Councils and the Office of Science and Technology has had the positive benefit of strengthening and focusing the dialogue between Government and the Research Councils. In general, we believe that the interests of the science communities have been represented well by this arrangement as illustrated in the 1997 Comprehensive Spending Review.

20. However, over time we have been concerned that the relationship between the Research Councils and the OST has become less clear in terms of both preserving the Haldane principle and representing the interests of the social and economic sciences specifically.

21. It is possible that the location of the OST within the DTI does not ensure its equitable position across Government Departments, and inhibits communication. A closer relationship with the DfEE, for example, might go some way to addressing the disparities in the research funding mechanisms. A more consistent Government approach to research funding would no doubt increase the quality and effectiveness of research in the UK. The approach to science policy and to research funding might also be clarified and strengthened through a clearer delineation of and demarcation between the roles of the DGRC, the Chief Scientific Adviser, OST and departments, with the Science Minister taking a higher profile in Government, perhaps of Cabinet rank.

Objective 8: Public Understanding of Science

22. Involving users in Research Council business does not necessarily lead to greater public understanding of or confidence in science. While White Paper objectives of greater interchange between scientists and users (eg government, business, industry) may have been achieved, it by no means follows that scientific applications are acceptable to the public—as recent events have demonstrated. There is a crisis of confidence in science and in scientific advice, and in part this is attributable to the perception that vested, often commercial, interests are defining scientific agendas and applications rather than the public interest. It follows therefore, that the White Paper may unwittingly have contributed to this crisis.

23. It is not sufficient to undertake campaigns to increase the public understanding of science as the White Paper advocated. These will be largely ineffective because the problem does not lie with the extent of public understanding, but in the trust and confidence the public has in the process of scientific policy-making and administration. Moreover, research undertaken by social scientists shows that far from impeding the progress of science and its take-up, the active engagement of the public on equal terms in debates and decisions about science, based on open access to scientific information, creates a climate of mutual trust in which science itself can flourish.

24. This is clearly an important issue for the Inquiry and has implications for the Government's Science and Innovation Strategy. The key points we would emphasise are:

- involvement and participation of the public and their representatives in the decision-making process of science;
- access to scientific information and outcomes;
- openness, transparency and public accountability ensured through regulation;
- the public interest objectives of the White Paper;
- independence of the Research Councils from sectional interests.

25. The ESRC is currently developing a major new research programme on *Science and Society* which will be examining the issues discussed in this section.

CONCLUSIONS

26. The ESRC believes that the objectives of the White Paper have generally been addressed with a distinct cultural change geared to increasing both the involvement of users and the impact of research. It remains a good basis for science policy, but there are a number of important points that we would like the Inquiry to cover:

(i) the appropriate representation of public interests and public involvement in science;
(ii) the role of the arts and humanities in achieving White Paper objectives;
(iii) clarification of the position of OST in relation to other departments, and to the Research Councils;
(iv) research careers: the pay and conditions of researchers;
(v) the independence of science from sectional interests; restatement of the Haldane principle;
(vi) the role of the Funding Councils in meeting White Paper objectives.

June 2000

ESRC COLLABORATION NETWORK

Activity	*Collaboration*	*Contribution to Corporate Objectives*	*Status*
Cities, Economic Competitiveness and Social Cohesion Programme	DETR	Theme 1 (Section 3.8)	Operating
Intangible Assets	DTI	Theme 1 (Section 3.8)	Consideration
Inland Surface Transport LINK Programme	EPSRC, DTI, DETR	Theme 2 (Section 3.9)	Operating
Climate Change Centre	NERC, EPSRC	Theme 2 (Section 3.9)	Under Implementation
Research Studentships in Environmental Themes	NERC	Theme 2 (Section 3.9) and Postgraduate Training (Section 4.2)	Implementation
Sustainable Technologies LINK Programme	DTI, EPSRC	Theme 2 (Section 3.9)	Consideration
People at the Centre of Communication and Information Technologies	EPSRC	Theme 5 (Section 3.12)	Implementation
Innovative Health Technologies	MRC	Theme 5 (Section 3.12)	Implementation
Teaching Company Scheme	DTI	Theme 6 (Section 3.13)	Operating
Teaching and Learning Research Programme	HEFCE, Scottish Executive, Welsh Assembly, DfEE	Theme 7 (Section 3.14)	Implementation
UK Centre for Longitudinal Studies	ONS	Theme 8 (Section 3.15) and Research Resources (Section 4.3)	Implementation
Growing Older Programme	EQUAL Initiative, (OST, MRC, BBSRC, EPSRC, NERC)	Theme 8 (Section 3.15)	Operating/ (Implementation
Age-Net	MRC	Theme 8 (Section 3.15)	Operating
Time Use Survey	ONS, DCMS, DETR, DfEE, DoH	Theme 8 (Section 3.15) and Research Resources (Section 4.3)	Implementation
Eating, Food and Health LINK Programme	BBSRC, MAFF, DoH	Theme 8 (Section 3.15)	Implementation
CENSUS Programme	ONS	Theme 9 (Section 3.16) & Research Resources (Section 4.3)	Ongoing/Implementing/ Consideration

Activity	*Collaboration*	*Contribution to Corporate Objectives*	*Status*
Collaborative Studentships	Various (in-CASE)	Postgraduate Training (Section 4.2)	Ongoing/ Implementation
Centre and Network for Evidence-based Policy	Various, especially DfEE, DETR, Home Office at current time	Research Resources (Section 4.3)	Consideration
CENSUS Data Units	Joint Information Systems Committee	Research Resources (Section 4.3)	Operating
European Social Survey	European Commission, European Science Foundation, various European National Funding Agencies	Research Resources (Section 4.3)	Consideration
Local Government Networking	Local Government Association and Local Government Management Board	Working with Users	Implementation
ROPAs	Various	Working with Users	Operating
Foresight LINK Awards	DTI and Various	Working with Users	Operating
ESRC/AIRTO User Fellow Scheme	AIRTO	Working with Users	Implementation
CONNECT Network	Various, Public & Private Sector	Working with Users	Operating/ Implementation

APPENDIX 41

Memorandum submitted by Novartis

INTRODUCTION

1. Novartis' contribution to the Science and Technology Select Committee's Inquiry into the impact of the 1993 White Paper "Realising our potential. A strategy for science, engineering and technology", focuses on the understanding of science amongst school children and the public.

2. Novartis is a world leader in healthcare with core businesses in pharmaceuticals, consumer health, generics, eye-care and animal health. Novartis is committed to improving health and well-being through innovative products and services. As a pioneer of research into the emerging technologies such as biotechnology and genomics, Novartis is committed to engaging society in a dialogue concerning benefits and the potential risks of scientific advancement in an open and frank manner.

3. In particular, we would like to respond to the question of how education can spread an understanding of science amongst school children and the public. We believe that it is the responsibility of scientists, research establishments, governments and NGOs, as well as companies like Novartis, to engage the public in a dialogue about scientific innovation. To this end, Novartis is engaged in a series of activities to enthuse and engage people about scientific development and innovation. These are explored in more detail below.

OVERVIEW OF SCIENCE AND EDUCATION

4. Public attitudes towards science and scientists are formed through a combination of personal contact and general experience. Those who have seen a life saved by an organ transplant or a treatment for schizophrenia, marvel at these achievements of modern science and hope for more. Much of what science has given to us, and that we benefit from in everyday life, is taken for granted. However, the disillusionment with science that has become more apparent over the last two decades comes from a variety of sources: major incidents at Seveso, Bhopal, Chernobyl, the greenhouse effect, the hole in the ozone layer and more local events such as BSE which have made it impossible for the public to view science in a measured/balanced manner; at the same time, the public are less able to engage critically with issues of science, particularly in understanding risks and benefits, because of insufficient and dated science education.

5. In recent years there have been numerous projects relating to public attitudes towards science. Most of the recommendations of the Bodmer report on the public understanding of science published in 1985 have been successfully implemented. These have led to newer initiatives and activities undertaken by COPUS, professional bodies, trade associations, individual companies and special interest groups. Some, such as SET week, have been aimed at the public in general, while others such as Satis (Gatsby Trust) have been more

directed towards schools. Whilst many of these have been considered successful, there is not much evidence to suggest that they have been effective or have provided value. The independent evaluation carried out of SET98 revealed some disappointing aspects. However, these initiatives have not led to evidence that the public is better able to handle issues and arguments around science. Neither have they seemed able to encourage more or better suited young people to enter higher education in the science fields.

6. Influencing public attitudes towards science is a long-term commitment. Not only is it important that there is an appropriate focus for various groups such as teachers, pupils, students, politicians and civil servants, business leaders and the general public, but it is important that the input is of the highest quality.

Schools and Science Education

7. Novartis is involved in a number of initiatives with schools to promote the understanding of science. For example:

- Novartis Webcast: As part of our commitment to the use of innovative ways of teaching and learning about science, Novartis is hosting a "Science Webcast" of two scientific experiments, live over the internet, later on this year. The webcast will carry out two experiments of relevance to the A-level curriculum. Scientists will carry out the experiments, which will be transmitted live over the internet into school classrooms throughout the country. As far as we can ascertain, this is the first initiative of its kind in the UK and we hope that the-lesson will pave the way for similar "remote" learning to be used in the future.
- Salters' Festival of Chemistry: The Salter's Chemistry Club was established to encourage youngsters to become involved in chemistry and also help to develop a more scientifically literate community. The Club's main objective is to make chemistry more visible, more interesting and attractive to 11–14 year old pupils by creating a network of Chemistry Clubs in schools which are linked into local companies and universities. The UK could see a shortage of high calibre chemists in the next 5–10 years, which would have far-reaching implications for the future of the science base in the UK. Salters Chemistry Clubs go some way to tackling this problem. The Festival has proved to be very popular and this year each school was given a £100 start-up grant and asked to design a set of experiments around a theme to demonstrate at the Festival. All students taking part received a certificate that they can add to their National Record of Achievement. Novartis sponsored this year's regional final in Brighton.
- Scientists for a Day: A-level students put on white coats and protective glasses to spend a day in the labs at Novartis Horsham Research Centre (NHRC). Chemistry and biology students from local schools were invited to be "Scientists for a Day" on 31 March and 1 February as part of the annual "Young Scientists Days" run in Horsham.

  The students did practical work and talked about the principles of drug research and development.

  Julia Hatto, from the NHRC says,

  "We've had younger pupils this year as they have more time to make the right choices should they opt for a career in science. The experience gives them a unique insight into the day to day work of a world-leading research centre".
- Novartis Community Partnership Day: Each year, Novartis employees around the world volunteer for community work. In 1999, in the UK the themes of education and environment were used. In the educational projects, research scientists put their skills to use in schools, teaching children about science and encouraging the next generation of innovators. At the Novartis Horsham Research Centre, for example, school children were invited in to explore the world of atoms and molecules and pupils were given the opportunity to conduct hand-on experiments.

The Novartis and the Daily Telegraph Visions of Science Photographic Competition

8. Novartis is involved in the running of a photographic competition via the pages of the *Daily Telegraph*, launched on 31 May 2000. The aim is to help develop public interest in science and its positive influence on our lives through photographs.

9. The competition, supported by the Royal Society, is open to amateurs, professionals, and scientists, and the photographs can cover any aspect of science whether it be biology, medicine, physics, chemistry, technology, engineering or mathematics.

Creating Sparks

10. Creating Sparks is a unique and ambitious national festival to be held in South Kensington throughout September 2000. It represents a high profile collaboration of the Sciences and the Arts and will be led by the British Association for the Advancement of Science.

11. Novartis is involved in the sponsorship of Performing Science, which will form part of the festival. Performing Science will be performed by the Y Touring Theatre Company who aim to create high quality theatre and drama that highlight current issues for a teenage (or adult) audience to engage with.

12. Performing Science will be a stimulating piece and the programme consists of a theatre performance, a discussion workshop afterwards and an education pack.

30 May 2000

APPENDIX 42

Memorandum submitted by the Association of Medical Research Charities (AMRC)

The Association of Medical Research Charities represents 110 registered charities which have as a principal activity the support of medical research in the UK. In 1999–2000 these charities funded more than £500 million in UK based research activity in addition to providing funds for buildings and other capital and infrastructure projects. Of this total, 50 per cent is accounted for by the Wellcome Trust. A list of member charities is attached as an annex.

The university sector is the principal beneficiary of charity funding for medical research and accounts for over 70 per cent of the funding. This reflects the fact that universities undertake a very wide range of research relevant to medicine and are able to attract funding for almost every field of research.

The charity sector in medical research is characterised by the fact that half the funding is for disease specific research. Prominent in the charity sector is the field of cancer research but the largest area is general medical research, principally funding from the Wellcome Trust. Charities fund a range of research relevant to their disease or objects, some of which will be basis or "blue skies", some strategic and some applied.

The charity sector, at least in part, reflects the public's priorities in medical research and provides a stream of funding which is significantly different from the statutory and commercial sectors. It is the principal or major source of funding for research in a wide range of areas, including cancer, ophthalmology, cystic fibrosis, diabetes psychiatry and heart disease. It is important therefore that the contribution of the charity sector is viewed alongside other sources of funding for UK research though it is equally important that the different roles are mutually understood and that complementarity is encouraged by Government policies.

Charities support research through a very wide range of funding schemes. There are broadly three types of support: responsive funding (where the charity agrees to support a research institute of an individual to undertaken the research that they have themselves identified that they wish to undertake); partnership support for research infrastructure or longer term programmes of research (such as unit funding, buildings, endowed chairs) in HEIs or the NHS where funding is provided for major initiatives which meet the objectives of both the charity and the host institution; and research supported in charities' independent institutes (eg ICRF). It is very unusual for AMRC charities to directly commission medical research.

Members of AMRC believe that peer review is essential in order to ensure the quality of the work being funded and to maintain distance between those who disburse funds and those who receive them. It is a condition of membership of AMRC that a strict and accountable process of peer review is used for all awards and the operation of this process is regularly monitored by the AMRC.

In responding to the call for evidence, the Association of Medical Research Charities (AMRC) has focused on only the issues it considers relevant to its field of medical research and there are some aspects of the Inquiry on which it would not wish to comment.

FORWARD LOOK

The annual publication of *Forward Look* has not made an obvious impact and AMRC remains unclear as to its intended audience and users.

AMRC considers that although the report offers an overview of the Government supported research base it does not adequately reflect the picture as a whole. Poor quality and lack of consistency in data included in the *Forward Look* on non-government funding gives a misleading picture of the overall research base, especially in medicine and health.

AMRC believes that this serves to minimise the impact of non-government funders, particularly the non-profit sector, and therefore provides a weak basis for policy making. Government could facilitate better decision-making by commissioning an annual *Forward Look* that took a wider view of the research base.

Technology Foresight

On balance AMRC believes Technology Foresight has helped in focusing Government departments and the scientific community on future directions for research and transfer to practical outcome.

Although the White Paper emphasised the importance of quality of life as well as wealth creation, AMRC feels that often Government has lost sight of the wider public benefit accruing from research and has a tendency to focus only on issues of wealth creation.

A preoccupation with technology transfer is an example of this: in medical research especially, much of the output is not commercially exploitable but nevertheless requires mechanisms to be in place if maximum potential is to be gained from it.

Government should also consider why venture capital for start-up companies is relatively poor in the UK compared with the USA. Part of this is a greater risk aversion in the UK and the difference in taxation between the two countries.

ACOST

The change from Advisory Council on Science and Technology to Council on Science and Technology was presumably to ensure that Government played a more direct role in directing research strategy.

It remains an important function of Government to have a good overall picture of the research base, emerging priorities and issues of concern. AMRC believes it is especially important that there is a body responsible for maintaining a UK-wide perspective.

However, AMRC has concerns about the way in which members of committees and advisory groups are selected and appointed and considers that the involvement of authoritative stakeholder groups in making recommendations for membership may enable DTI/OST to include a better balance of perspectives.

AMRC considers that broader and ongoing networks of contact with stakeholders should be developed by OST rather than the current mechanisms, which depend on a limited range of broad subject committees.

Technology Transfer

Since the introduction of the 1993 White Paper *Realising our potential* there has undoubtedly been a greater emphasis on technology transfer within the science base which may, at least in part, be due to the recommendations of the White Paper. A number of changes were already occurring in higher education and it is not clear that these or the gathering momentum were due to the White Paper.

Charities recognise that over the last eight years higher education technology transfer has improved and there are some notable pockets of expertise and success. However, some difficulties remain: in many universities the facility for technology transfer remains problematic and is not recognised as a high enough priority or is perceived as against the culture of the sector. There are also differences of view with regard to the community of users that university technology transfer exists to serve.

There is a shortage of university expertise mirrored in a lack of clarity about what support systems are available through Government and little awareness of best practice elsewhere. AMRC supports strongly the principle that inventors should benefit from their work but wonders whether the current mechanisms in HEIs focus too strongly on short term gains. There is much further work to be done in higher education and government in considering how these issues can be overcome.

The 1993 White Paper did not foresee the range of issues that have arisen from the globalisation of research and variations in patenting law. For example, the significant differences in UK and US patent law are important and confusion can act against innovation and successful technology transfer. One issue for future consideration by Government is the question of a "grace period" for patenting.

Appointment of the Director-General for the Research Councils

It has been useful for there to be a single point of contact for all the research councils and the appointment of the director general of the research councils built upon this.

Clearly the Government has a responsibility to manage the research councils but AMRC would stress that it believes the focus of Government strategy should be on enabling and facilitation.

OST

AMRC considers the creation of a Minister for Science and Technology and the Office of Science and Technology has been very positive. They have provided a focus and voice for science within Government and wider recognition of the important role Government has in creating the right environment for science to thrive in the UK.

GOVERNMENT ROLE

AMRC considers it is primarily Government's role to support a science base that enables scientists to engage effectively and innovatively in research and not to direct that research effort in its totality.

While AMRC would encourage the Government to identify strategic initiatives or needs that require central leadership, AMRC believes it is probably undesirable for Government to become increasingly involved in directing the research itself.

Government should focus on mechanisms, which will enable research to be undertaken, and the fruits of research to be transcribed into practical outcomes.

Increased Governmental involvement in the way funding for research is used has had a perverse influence in that Government takes on an increased accountability for the research which is undertaken.

INTERNATIONAL COMPETITIVENESS

Confusion about intellectual property law is one of the possible disincentives that might drive research overseas.

The pharmaceutical industry in the UK does itself undertake much first class research and AMRC considers it is important that OST works to ensure that the research environment continues to encourage this investment and to be aware that regulations introduced by other Government departments may create disincentives for research investment. In medical research, issues that concern both the charities and industry include difficulties in organising large scale clinical trials and animal licence procedures.

PUBLIC UNDERSTANDING OF SCIENCE

The AMRC considers that despite Government efforts it is clear that it has not achieved its aspirations to improve the public understanding or confidence in science contained in the White Paper.

The public understanding of science has not been helped by adverse media comment on the high profile cases of cloning and GM foods.

Government should develop a better understanding of its own role and credibility in developing public confidence in science. The recent House of Lords report on Science and Society makes many valuable recommendations for Government and others and AMRC hopes that the Government will give them serious consideration.

It is of course important that Government consults experts when drawing up its pronouncements but this must be done in the context of the reality of scientific knowledge.

The AMRC considers that there are some non-governmental organisations which are more trusted by the public for their contribution towards science-based decision making and that Government should develop mechanisms for working with such bodies rather than seek to direct public understanding of science initiatives itself. AMRC suggests that consideration is given as to how OST might facilitate a wider range of PUS activities through partnerships and funding schemes.

AMRC and the medical research charity sector can play a very particular role in helping build public trust and confidence in science because of their direct public support and their focus on the positive use of science for the alleviation of suffering and improvement in health. They are seen as independent of Government (politics) and industry (profit) and do not speak on behalf of the scientists themselves. This unique position is one that the Government could note.

Government funding of polls in public awareness and understanding of science has been very helpful and further work along these lines should be encouraged.

AMRC would wish to suggest that civil servants from DTI/OST might be seconded for a period of time to AMRC or member charities in order to improve understanding of differing roles and perspectives and to foster greater collaboration on common concerns.

July 2000

Annex

ASSOCIATION OF MEDICAL RESEARCH CHARITIES

Membership 1999–2000

Member Charity	*UK Medical Research Expenditure 1999–2000*[53]
Action Cancer	144,587
Action on Addiction	547,367
Action Research	5,366,276
Alzheimers Disease Society	626,491
Arthritis Research Campaign	19,976,000
Association for International Cancer Research	2,993,909
ASBAH	66,746
Ataxia-Telangiectasia Society	6,491
Bardhan Research and Education Trust	209,255
Barnwood House Trust	299,723
Beit Memorial Fellowships	84,692
Blackie Foundation Trust	20,000
Brain Research Trust	1,237,000
Breakthrough Breast Cancer	3,000,000
Breast Cancer Campaign	500,000
British Brain and Spine Foundation	345,086
British Council for the Prevention of Blindness	200,000
British Heart Foundation	39,691,072
British Liver Trust	100,000
British Lung Foundation	1,242,919
British Neurological Research Trust	268,706
British Occupational Health Research Foundation	300,000
British Retinitis Pigmentosa Society	241,675
British Vascular Foundation	10,000
Cancer Research Campaign	56,000,000
CFS Research Foundation	68,235
Chest Heart and Stroke Association Scotland	493,780
Children Nationwide	1,000,000
Children's Liver Disease Foundation	309,000
Chronic Disease Research Foundation	60,000
Chronic Granulomatous Disease Research Trust	450,000
CLIMB	10,973
Cystic Fibrosis Trust	1,900,000
Deafeating Deafness	626,674
Diabetes UK (formerly known as the British Diabetic Association)	4,336,000
Digestive Disorders Foundation	500,000
DEBRA	483,767
East Grinstead Medical Research Trust	534,000
EMF Biological Research Trust	300,500
Epilepsy Research Foundation	400,000
Foundation for Nephrology	350,000
Foundation for the Study of Infant Deaths	354,208
Friedreich's Ataxia Group	210,000
Guide Dogs for the Blind Association	600,000
Guy's and St Thomas' Foundation	8,209,000
Homoeopathic Trust for Research and Education	62,327
Huntingdon's Disease Association	45,000
Imperial Cancer Research Fund	56,100,000
Inspire Foundation	83,000
International Spinal Research Trust	961,194
Iris Fund for the Prevention of Blindness	700,000
Juvenile Diabetes Foundation (UK)	378,895
Leukaemia Research Fund	16,800,000
Leverhulme Trust	250,000
Lister Institute of Preventive Medicine	1,290,000
Little Foundation	60,000

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[53] Excludes funding for buildings and other capital projects.

Member Charity	*UK Medical Research Expenditure 1999–2000*[53]
Liver Research Trust	740,000
Maria Curie Research Institute	2,300,000
Mason Medical Research Foundation	88,800
Mental Health Foundation	300,000
Meningitis Research Foundation	980,000
Migraine Trust	122,793
Motor Neurone Disease Association	770,000
Multiple Sclerosis Society	1,700,000
Muscular Dystrophy Group	1,398,000
Myasthenia Gravis Association	257,651
National Association for Colitis and Crohn's Disease	274,709
National Asthma Campaign	2,500,000
National Back Pain Association	20,000
National Eczema Society	12,051
National Endometriosis Society	15,000
National Eye Research Centre	450,000
National Heart Research Fund	828,154
National Kidney Research Fund	2,148,066
National Meningitis Foundation	611,059
National Osteoporosis Society	350,000
Neuro-disability Research Trust	180,000
Northern Ireland Chest Heart and Stroke Association	190,000
Northern Ireland Leukaemia Research Fund	295,000
Northwest Cancer Research Fund	800,000
Novartis Foundation	1,933,214
Nuffield Foundation	450,000
Parkinson's Disease Society	1,100,000
Primary ImmunoDeficiency Association	250,000
Progressive Supranuclear Palsy Association	57,684
Psoriasis Association	80,147
Remedi	200,000
Research into Ageing	541,000
Restoration of Appearance and Function Trust	843,219
Royal College of Radiologists	113,482
Royal National Institute for the Blind	325,898
Royal Surgical Aid Society	5,000
SCOPE	375,000
Scottish Hospitals Endowments Research Trust	1,035,460
Sir Jules Thorn Charitable Trust	1,865,766
Smith and Nephew Foundation	290,000
Special Trustees of the United Birmingham Hospitals Trust	143,748
Stroke Association	1,300,000
Tenovus	1,813,750
TFC Frost Charitable Trust	180,000
Tommy's Campaign	1,100,000
Tuberous Sclerosis Association	256,913
Tyneside Leukaemia Research Fund	200,000
Ulster Cancer Fund	325,723
Wellbeing	956,400
Wellcome Trust	279,047,000
Wessex Medical Trust	2,177,035
William Harvey Research Institute	1,300,000
Wishbone Trust	334,200
Yorkshire Cancer Research	5,000,000
Total	552,336,470

APPENDIX 43

Memorandum submitted by the Council for the Mathematical Sciences

Thank you for inviting the Institute of Mathematics and its Applications, London Mathematical Society and The Royal Statistical Society to make a late submission for the forthcoming White Paper on Science and Innovation Strategy. Since none of the three societies were involved in the consultation for the previous White Paper, it would seem to be more appropriate that our submission look to the future and consider the strategic concerns of mathematics, its interactions with other areas of science and technology, and its potential contributions to wealth creation and the quality of life.

The applications of mathematics have undergone a tremendous growth over the past decade. Mathematical ideas, methods and techniques now pervade nearly all other scientific disciplines and engineering, and underpin many developments which are essential for the nation's economic well-being and for improvements in the quality of life. Diverse examples of this key underpinning role include:

(a) the use of statistics in the understanding and control of epidemics, the management of risk and the use of stochastic methods in finance;

(b) the secure transfer of information using cryptography, managing the increase of internet traffic and the use of mathematics in software design and verification;

(c) the modelling, analysis and hence interpretation of complex biological data sets, such as arise from the Human Genome Project;

(d) the new mathematical techniques being used in Engineering and Materials Science in problems ranging from the design of smart materials to the use of virtual reality in simulating complex physical processes.

The UK has an excellent history of mathematical scholarship and British mathematical research is still amongst the best in the world. One would expect that any strategy for science would wish to optimise the benefits from mathematics and its applications. It is vital to appreciate and understand the tension between so-called "blue skies" mathematical research and applications. Some applications, such as in computing and modelling, are reasonably predictable; others are not so easily foreseen—such as the use of number theory in cryptography and the use of topology in understanding defects in crystals. In order to flourish, most scientific disciplines require their own internal goals. Despite the immense importance of its applications, mathematics will not flourish in a purely service role. Continuing support is therefore needed both for "blue skies" mathematical research as well as for more applied kinds of research.

The two principal problems that are most likely to inhibit the realising of the potential benefits of mathematics in the UK are:

(a) The lack of appreciation by the public and policy-makers of the depth, importance and diversity of the application of mathematics. In consequence the British mathematics community currently suffers from rather low morale. Here we should mention that we are greatly concerned about the current low funding base for mathematics in the EPSRC, although we do note with pleasure the recent increases in funding and the joint initiatives with other research councils, both of which recognise the need for improvement.

(b) The nation will need an increasingly mathematically skilled and trained work force to compete on the international stage. One aspect of this problem is well illustrated by the current difficulty in recruiting well qualified Ph.D students. Also the high demand for students with mathematics doctorates is causing immense difficulties in maintaining the academic base in mathematics that is essential to train the next generation of mathematicians and continue the current level of research.

25 July 2000

APPENDIX 44

Memorandum submitted by the Higher Education Funding Council for England

THE EXTENT TO WHICH THE OBJECTIVES SET OUT IN THE 1993 WHITE PAPER REALISING OUR POTENTIAL HAVE BEEN REALISED

The 1993 White Paper sought to improve the nation's competitiveness and quality of life by maintaining the excellence of science, engineering and technology in the United Kingdom through:

- developing stronger partnerships with and between the science and engineering communities, industry and the research charities;
- supporting the science and engineering base to advance knowledge, increase understanding and produce highly-educated and trained people;
- contributing, according to the United Kingdom's strengths and interests, to the international and particularly European, research effort;

- continuing to promote the public understanding of science and engineering;
- ensuring the efficiency and effectiveness of Government-funded research.

We believe that the approach was generally right, and continues, broadly, to be correct. It recognises the important reasons for public funding of research, the significant Return on Investment from such funding, the benefits of the discretionary application of funding by institutions, the need to encourage more applicable research, the inappropriateness of a National Plan and the necessity to support strategic decision making about research activities hosted by HEIs, the importance of partnership and the significance of highly trained individuals as a "research output".

We consider that the major concern, that we do not capitalise on the strength of our science base and translate it into economic and quality of life improvements was valid, as was the concern that there should be greater public understanding of research.

We consider that there has been a cultural change in respect of both these areas of concern. There is within HEIs a much improved ability, and greater willingness, of researchers to engage in knowledge transfer activities, and schemes have been developed to embed such activities within HEIs as a core mission.

The most authorative account of the change that has occurred since 1993 is that provided by the 1998 PREST study which document increasing performance in a number of areas including the number of patents filed by HEIs; and the number, depth and variety of relationships between HEIs and commercial organisations. However, it did also identify that good practice was patchy; spreading and embedding good practice in this area is one of the key objectives of the HEROBC initiative we recently launched with DTI and DfEE. It is also clear that "pull" from industry needs to increase. Industry's investment in the UK research base is increasing at almost 10 per cent per annum—in recognition of the added value provided by the UK research base. However, as shown in table 1 below, in-house corporate R&D in the UK is low compared with that in other OECD countries. This evidence illustrates the need for an increase in the capacity of UK industry to engage in research and knowledge transfer.

Table 1

In-house business R&D as a proportion of GDP (1997)

UK	1.2 per cent
Germany	1.6 per cent
France	1.4 per cent
Italy	0.6 per cent
Japan	n/a
Canada	1.0 per cent
USA	2.0 per cent

The Government's strategy to increase the academic-industry interface has been supported by the development of a number of initiatives:

- Co-operative Awards in Science and Engineering (CASE).
- LINK
- Teaching Company Scheme
- Faraday Partnerships
- University Challenge
- Enterprise Centres.

The HEFCE has made its own contribution through the Joint Research Equipment Initiative (JREI) and HEROBC. Also, changes to the assessment process for the 2001 RAE, and those proposed for any future exercise, will further encourage applicable research. However, we do not believe that the assessment or funding processes should provide a premium for work with industry. Rather, we note the benefits of increasing HEROBC funding to support knowledge transfer.

Another facet of the increase in the level of engagement with the world outside of HE is a significant improvement in the public understanding of science. In addition, there have been positive changes in the relationships between funders, and national international changes in the research landscape mean that it is timely for the White Paper vision to be revisited.

We address below both the specific and general issues raised.

Response to Your Specific Questions

The annual publication of the Forward Look

As the science and engineering base becomes increasingly complex, and its importance as a source of knowledge to be transferred into business, and the community more broadly rises, it is vital that all stakeholders in the research base have a clear understanding of the Government's policies, as it still remains overwhelmingly the major funder and provides a solid structural basis for investment by others.

We consider that replacing the annual review with the *Forward Look* has improved the ability of Government to communicate its aims and objectives, and signalling them to the research community and other funders and stakeholders helps to support coherence and complementarity.

The *Forward Look*, as a single document containing most salient information about policy and performance, is particularly useful for those who wish to rapidly access and understand key information on how the research base is organised, how it is performing and how it is likely to perform in the future.

The creation of Foresight

We believe that Foresight continues to be valuable in bringing together stakeholders in the science and engineering base. The refinement of its objectives and processes over time has produced an effective framework for identifying the significant problems we face in the future and how funders, researchers and users may act in concert to address these problems.

We are pleased that the process has broadened, and developed a more thematic approach alongside the sectoral approach adopted in the first round, both of these enhancements will ensure a more considered and effective response to solving the problems we face as a society.

The Council will continue to play its part in promoting Foresight. Many project funders have Foresight-related strategies and institutions need to build research capability in these areas. We are committed to ensuring that within the boundaries defining high quality research the RAE recognises work addressing Foresight and other Government policies.

We remain committed to a very visible contribution to Foresight through our continuing sponsorship of the scheme we created in response to the launch of Foresight—the Joint Research Equipment Initiative. JREI has been running for three years with the primary aim of providing the infrastructure for high-quality research in HEIs, especially where relevant to Foresight priority areas. It has proved to be extremely effective with over £170 million of equipment purchased so far by HEFCE, with the assistance of matched funding from industrial partners.

New approaches to technology transfer initiatives and improving access for SME's to innovation

We prefer to use the term knowledge transfer as a generic term to describe the wide variety of interactions between HEIs and users—we also recognise that this transfer may be much wider than to businesses, as important as that is, but also includes what is broadly described as the "community"—the voluntary sector and other not for profit organisations who make a vital contribution to social development of our nation. A broad definition is also necessary to include work involving government departments such as the Department of Health.

We believe that there has been a fundamental change in the agenda for higher education since the publication of the last White Paper. HEIs are now widely acknowledged, within the sector and outside, to be central to society's attempt to address issues of profound economic and social importance, many of which have a significant regional dimension. This shift from a conception of the university as an "ivory tower" to one of universities and colleges taking an important and, in some cases, central role in delivering key public policy objectives is one of the most important underlying trends of recent years.

An important part of HEFCE's strategy is to ensure that higher education is responsive to the needs of business and industry; HEFCE encourages partnerships between HEIs and industry, knowledge transfer, and the development of employment skills.

For 1998–99, we allocated £20 million for the long standing Generic Research Initiative to provide incentives to institutions to collaborate with users on long-term research leading to expertise and knowledge which can be used by higher education, industry and the community at large.

It is in part to spread and intensify much of the good practice that exists in the HE sector that we launched our most recent initiative, the Higher Education Reach Out to Business and the Community fund. This targeted funding for institutions will provide an incentive to build a sustainable and broadly based capability to respond to the needs of industry and the community.

The emphasis on building general capability, to support the myriad of possible types of interaction between HEIs and users, distinguishes this approach from that of other specific funding initiatives in a parallel with the dual support system. Funding provided to HEIs under the proposed programme will lead to improvement not only in their delivery of knowledge and services to industry but also in their capacity to respond to related initiatives mounted by other agencies. It is also hoped that this approach will embed knowledge transfer within HEIs as a third core activity alongside teaching and research.

It is clear that HEROBC should fund interactions that are more complex than HEIs working with major industrial employers. Technology transfer also needs to occur into SMEs, the public sector, and the community. Also, in making HEROBC a success, it will be essential that institutions with a smaller research base, but which demonstrably "punch above their weight" in terms of facilitating relationships with users (often these will be institutions interacting with SME's) are rewarded for their excellence in this area.

We have also, as part of our recent Fundamental Review of Research Policy and Funding, developed a proposal to provide a modest amount of new funding for a "Capability-development" funding stream. This initiative would provide a framework for research that had a distinctive contribution but which might not be best supported by QR and the current approach to selectivity:

- emerging subjects requiring capability building;
- research of national, regional or local importance.

Although we believe the case for HEROBC, newly established in partnership with DTI and DfEE, is clear, and that the capability development funding stream will provide significant benefits, overall we would prefer to see a reduction in the number of initiatives to which HEIs and others are subject. We therefore welcome moves on the part of DTI to simplify the structures under which companies can access help to innovate from Government. The panoply of schemes can be confusing even for the users who have individuals dedicated to interacting with the research base, it is even more confusing for SMEs who can not justify such staff.

We also welcome the Government's recent move to provide tax relief for SME's investing in R&D. This is a significant change in policy from that outlined in the 1993 White Paper and will enhance the "pull" from industry, an area where we compare poorly with other OECD countries, at the same time as rising public funding for knowledge transfer increases the "push" from HE.

The re-organisation of the Research Councils and associated management changes

We believe that there is considerable merit in the present RC structure, as it establishes research project funding organisations that can communicate effectively with, and provide funding intelligently to, their broad subject communities who differ somewhat in their requirements and organisation.

However, as research becomes increasingly collaborative and inter and multidisciplinary, the RCs must function increasingly effectively at the areas where they interface with one another (and with the Arts and Humanities Research Board as their analogue in this area). We consider that there are particular benefits of HEFCE funding in facilitating the "joining up" of research funded by others. We expect individual project funders to be increasingly interactive with each other.

Also, we would wish overall to reduce the accountability burden on institutions—to free up management and academic time—without reducing the appropriate level of scrutiny of those in receipt of public funding. We believe that significant gains can be made in this area if public funders work more coherently in partnership together, and

(a) do not ask for more information than is necessary;

(b) can agree to rely on data provided to others for their own purposes so that information is only provided once.

We would wish to work closely with the individual RCs in this endeavour,

It is vital that we continue to encourage applicable research—whether it contributes to wealth creation or quality of life—the explicit commitment to this objective in the missions statements of the RCs was therefore welcomed. We have made our own commitment in this area through the Guidance to Panels for the 2001 RAE and there are a number of recommendations to further encourage applicable research arising out of our Fundamental Review of Research Policy and Funding. As noted above, one of these recommendations is the creation of a "capability development" funding stream to support applicable research and research or local, regional or national relevance. However, we would caution funding research just because it is "relevant". It would be intolerable, for example, if in the RAE research were marked up because it was deemed to be "useful", or if high quality research were marked down because it was deemed not to have potential for application. It is notoriously difficult to assess the potential utility of much research, and there are ample examples of discoveries, which proved unremarkable at the time which subsequently had decisive impact. We see no dichotomy between quality and applicability—application is often just a question of time, and with the increasing speed to market of products based on research-led innovation this time is shortening. We are committed to ensuring that the RAE "sees" the quality in all research types of research—irrespective of its nature or purpose.

Given the level of resources allocated by OST (including the contribution to training of researchers and costs of access to international and national facilities)—we believe it is essential that there is a Director General to oversee the coherent and co-ordinated development of funding policies between and within the Research Councils. We also believe it is important that there is someone who can speak with a single voice to Government, and others, on behalf of the Research Councils as well as listening to the views of stakeholders.

Increasing the public understanding of science

We consider that public funders of the science and engineering base have a responsibility to encourage researchers to share their research with the public, and this encouragement should exist at all levels within the science and engineering base. However, we believe that this is most effectively done by reflecting the particular missions of funders, drawing on the natural leverage that they have, rather than adopting a one-size-fits-all approach.

We consider it appropriate that the Research Councils have a range of approaches in this area—some specific initiatives with ring-fenced funding and other, more systemic approaches.

The Higher Education Funding Council for England considers dissemination of research to be part of the core mission of all institutions. We encourage university researchers to disseminate their work not only to their peers in reviewed publications, but also to the general public more generally. We consider that by encouraging a more strategic approach to research, the Research Assessment Exercise (RAE) has increased both the quality of the research and its dissemination and impact. The Funding Councils have encouraged 2001 RAE panels to consider dissemination, and impact outside the discipline, as secondary quality indicators. Such an approach has been enthusiastically embraced by the education panel, for instance.

As part of the fundamental review we commissioned two substantial pieces of work from the Higher Education Policy Unit of the University of Leeds that provide evidence of increased relative output, greater growth in national and international collaboration in the UK than in other countries, increasing interaction within industry, and greater correlation of industrial and public funding. This indicates that UK researchers are much more likely to communicate the outputs of their research. This, of course, is different from targeted attempts to improve the public understanding of science in specific areas like GM foods and the human genome, which is the legitimate role of the Research Councils (and Royal Society) but is powerful evidence of HEFCE policies contributing to an increasingly outward looking academic community that is engaged in the problems of today. In addition, the HEROBC funding stream rewards collaborative research with business and the dissemination of research results with a potential for commercial development.

RESPONSE TO THE QUESTION OF WHETHER THE OBJECTIVES OF THE 1993 WHITE PAPER REMAIN APPROPRIATE, WHERE NOT COVERED IN OUR ANSWER ABOVE.

Partnerships

We consider that one of the most significant changes to have occurred since 1993 is the increasing extent to which research funders, users and researchers have worked in partnership to achieve common aims. HEFCE has a unique contribution to make in this regard, as it funds across the entire research landscape and has access to information about, and ability to influence, institutional as well as disciplinary activities. Thus, for example, we established the Arts and Humanities Research Board—in partnership with the British Academy, SHEFC, HEFCW and DENI and we have established a number of joint task groups to address areas of concern—for instance with the Confederation of British Industry, Royal College of Veterinary Surgeons and Department of Health. In fact the latter has led to the creation of a strategic alliance with the Department of Health that outlines the basis on which the two organisations will work together to develop efficient and effective policies to support health-related research.

The partnership with OST, along with the other Funding Councils, in support of the dual support system, is absolutely key to the effective development of the research base. In particular we consider that HEFCE funding has a unique role in sustaining research rigour and facilitating the "joining up" of research funded by others. The Science and Engineering Base Co-ordinating Committee plays an important role in supporting this partnership, recently enhanced through being joined by the Director of Research and Development for the Department of Health. Both the first and the current DGRC have been invited to become members of the HEFCE board, and there are in addition many other examples of cross-representation to ensure that research issues across the dual support boundary are addressed coherently and complementarily.

We consider therefore, that the reorganisation of the Research Councils, and new management structures have improved the basis on which public funding for research is provided. However, we believe that the enhancement of the links between OST and HEFCE will continue and further augment the efficiency and effectiveness of the dual support system.

However, we also recognise the importance of the Charitable sector in support of research activity and, increasing particularly through the Wellcome Trust in particular, research infrastructure. This contribution is not only extremely welcome generally, it is particularly important in, and may in fact in large part be responsible for, the very high levels of performance of the UK biomedical science community, a key area to support health care provision and economic development. We were delighted that by joining JIF we were able to build on the joint initiative we had previously established with the Wellcome Trust to fund research equipment in the life sciences. We consider that the importance of the charitable sector will grow and we have therefore recently commissioned a study to map links between HEIs and the charitable sector in order that best practice can be identified and then spread.

Efficiency and effectiveness of Government-funded research

We believe that the evidence in table 2 below demonstrates that the provision of public funding for research in the UK is extremely efficient and effective. The dual support system has proved extremely resilient, despite the funding strains, and continues to support plurality, diversity and dynamism. Unfortunately, there is no mechanism to determine how much more successful the UK could have been if the system had been better funded, or what additional value would arise from greater efficiency and effectiveness.

Table 2

PAPERS PER $ MILLION, CITATIONS PER $ MILLION, AND PAPERS PER RESEARCHER FOR SELECTED LEADING INDUSTRIALISED NATIONS (1997)

	Papers per $ Million[54]	*Rank*	*Citations per $ Million*[55]	*Rank*	*Papers per Researcher*[56]	*Rank*
United Kingdom	16.0	1	70.5	1	11.2	4
Canada	14.7	2	61.0	3	10.9	5
Australia	13.9	3	48.3	7	10.2	6
Ireland	12.9	4	38.2	10	7.0	11
Spain	12.1	5	36.3	11	5.2	13
Sweden	11.3	6	52.3	4	15.7	1
Switzerland	10.9	7	65.7	2	15.3	2
Netherlands	10.3	80	48.7	6	11.3	3
France	9.8	9	38.3	9	8.4	9
Belgium	9.5	10	41.3	8	9.9	7
United States	9.2	11	49.0	5	9.2	8
Italy	9.0	12	34.0	12	5.6	12
Germany	7.9	13	31.9	13	7.2	15
Portugal	7.2	14	17.9	15	1.8	16
Austria	7.1	15	25.9	14	7.3	10
Japan	3.6	16	11.7	16	4.5	14

Source: Katz, 2000—taken from OECD, Main Science and Technology Indicators, OECD Statistics, 1999 and ISI National Science Indicators.

As part of the Transparency Review announced in the previous Spending Review White Paper, new costing processes are being piloted at eight universities with the expectation that an agreed approach can be rolled out to the sector that will provide institutions with a much better understanding of their expenditure on different activities; and cost dynamics, so that the efficiency and effectiveness of their expenditure will be increased.

However, there is a continued concern about research infrastructure in relation to our ability to compete in an increasingly global research base, and this will not be addressed by an increase in efficiency and effectiveness—this requires additional funding. We welcome the recent injection of capital funding by the Government and the Wellcome Trust via the Joint Infrastructure Fund (JIF), to which the HEFCE also contributes. However, we see a continuing need for further capital and recurrent support and a need to establish a proper and sustainable project/infrastructure balance. The announcement of £1 billion for the years 2002–04 from public funding and the Wellcome Trust is a very important contribution on the capital side, but the Funding Councils recurrent funding for these three years is not yet known.

Another area of concern is the environment for, and experience of, research trainees, who may be working in less than optimal conditions. We also believe that financial constraints prevent the development of an appropriate research base in a number of significant emerging areas.

Sustaining the Excellence of the Science and Technology Base

As indicated in Table 2 above, the United Kingdom's HE research base, at a high level of aggregation, is very successful. On many measures, our performance matches that of the best in the world in terms of its quality, its impact and its efficiency.

Other evidence we have collected as part of our Fundamental Review of Research Policy and Funding indicates that the application of a policy of selectivity over a long period has stimulated a constructive and coherent management response by institutional managers, who have become more strategic in their approach to research management. It has also produced an increase in concentration of research funding. As a result of these influences, the output of the most active universities has both increased and improved: they are delivering more, better research. Since both the volume and the quality of research have increased at a faster rate than the funding inputs, there has been a significant increase in efficiency. The timing of these changes in the productivity of the research base can be demonstrably linked to the inception of the RAE cycles and seems, therefore, in large part attributable both to the policy's funding effects, as Funding Councils and institutional funding has been targeted to encourage and reward high quality research, and to better management of resources.

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[54] Higher education R&D expenditures in 1997 in $ dollar PPP.

[55] Number of citations per paper from ISI National Science Indicators.

[56] Number of papers per researcher, OECD sources.

However, we consider that the present system of dual support, which allows a plurality of decision and funding points and permits institutions and individual academics to exercise judgements about what research to pursue, has also been essential in supporting this change. We believe there has been a powerful combined effect from the dual effects of selectivity on the one hand and changes in the structure of the Research Councils which have seen them become more innovative, focused on more appropriate and coherent disciplinary groupings, and taking a more strategic approach to funding which complements that of the Funding Councils.

Encouraging Private Investment in Innovation

It is particularly important to build on the HE sector's success in working alongside industry to produce research that contributes to the economic development of the country, and to produce research that is of interest to users and other partners to enhance the health and social development of the nation.

Evidence we have collected as part of our Fundamental Review demonstrates that closer correlation between public and commercial funding in the UK than in the USA, although the average industrial funding of USA universities is higher (11 per cent compared with public funds, whilst it is about 8 per cent in UK).

In the UK, income for pure research (from public sources including Research Councils and charities) and applied research (from industry and commercial sources) is broadly correlated across small and large institutions, and this does not change much when small institutions are excluded (0.88 for all institutions, 0.86 after excluding minor research institutions). It appears, therefore, that those institutions most successful in attracting research grants tend also to be those most likely to attract industrial funding. There is no evidence of a separation of innovation and application. In the US, income for pure and applied research is only poorly correlated across small and large institutions.

However, it is also clear from OECD statistics in table 1 that UK companies are not investing enough in their own innovation, outside the HE sector. The UK corporate spend on non-HE research in 1997 of 1.2 per cent of GDP, compares unfavourably with that in Germany (1.6 per cent), France (1.4 per cent) and the USA (2.0 per cent).

We welcome the recent changes announced by the Chancellor to promote corporate investment in R&D, particularly by SME's but consider more needs to be done to increase the innovativeness of UK companies and their desire to "pull" from the science base.

Streamlining Knowledge Transfer Schemes and Focusing them on Clear Goals

We consider that this should be a key aim, and is essential in order to reduce the confusion for academics and industry alike about the nature and purpose of public support for knowledge transfer—a recent HEFCE survey of schemes in this area identified that there were in excess of 60 publicly funded schemes supporting HEI—Industry interactions. Many of these schemes are too small and of too short duration, often seeking to respond to manifestations of problems rather than the underlying problems.

Longer term, and more substantial support is required in this area to embed knowledge transfer activities within institutions as a core activity.

Fostering Regional Networks

Regional networks and collaborations between institutions will be an increasingly important feature of the HE landscape in the future.

All regions present academics with research opportunities, either because organisations in a region sponsor, or collaborate in, research activity or because regional social, economic or other factors may themselves form a topic for research.

However, we believe it is erroneous to suggest that there is a dichotomy between research of international quality and regional relevance. We do not believe that there is any inherent conflict between developing excellent research and engaging with the regional agenda. Rather that there are dangers that research can become parochial and inward looking if it is not linked to the wider research effort. In addition, excessive focus on incremental regional research may mean that transformational national or global developments are not embraced. The consultancy study we commissioned as part of our Fundamental Review of Research Policy and Funding confirmed that researchers do not see regional links as sufficient to sustain leading edge research capability on their own.

In today's environment global companies can go wherever they wish to find the research they need: it is international excellence a region needs to attract such companies. Smaller technology-based companies also locate themselves where there is a research base of international excellence, or are spun off by institutions on the basis of excellent research. Evidence collected for us on collaboration between HEIs and user communities demonstrates that institutions also recognise that interaction with local and regional users makes a vital contribution to their own mission, not merely because industrial or commercial users have access to resources which can support fundamental research to international levels of excellence, but also because a balanced portfolio of fundamental and applied research is recognised as a necessary goal in itself, setting up two-way flows of information, people and skills to the benefit of researchers as well as users.

Thus for global companies, who have the resources and knowledge to seek out the best research wherever it is found, in the UK or abroad, the distinction between national and regional locations is usually unimportant.

There are also user communities, however, for whom locality is much more important. Companies without a history of engagement with the HE sector need to be able to commission research of relevance to their needs from a local institution without being forced to navigate the complex landscape of research in UK higher education. Local government and NHS Trusts need to be able to commission research relevant to local service delivery. This research must be good enough to meet the purposes of the users. In addition, we recognise that there are subjects that are regionally based—like health care delivery. This means that we must have a concern for the accessibility of internationally excellent research to sophisticated users, but we must also have a concern for the excellence of the research which is accessible to users with narrower horizons or less experience of interaction with the HE sector, who are less able to identify and access the best research or whose problems may not be demanding enough to engage the attention of the most advanced researchers.

Improving the Flow of Skilled Scientists and Engineers to Industry

One of the principal outputs of the research base is a supply of trained researchers. These individuals may go on to pursue academic careers, but increasingly their skills and knowledge are valued by society more widely, and by industry in particular.

RAE panels have been encouraged to place more emphasis on assessing the research culture in the 2001 exercise, and in this context they will consider factors related to postgraduate training. However, we consider that research training is a key indicator of sustainability and therefore warrants more explicit recognition in the assessment process. We will therefore be recommending as part of our Fundamental Review of Research Funding and Policy that research training be the subject of an explicit, but linked, assessment process involving minimum standards agreed with the Research Councils, Industry, Charities and others.

Improving the Ability of the Science Base to Play a Role in the Knowledge Economy

A different issue as regards postgraduate research training is the number of PhDs being produced. We consider that an advanced modern society needs a significant number of students with higher degrees. As an indicator of R&D capacity the number of PhD graduates is particularly important. Such graduates are needed to underpin teaching in universities and colleges, particularly for third year work at bachelors level and for postgraduate programmes. They are also, of course, needed to carry out and develop research in universities, industry and the wider economy. Most importantly, it is from PhD students that the next generation of academic staff are drawn.

Taking 1997–98 as the last year of fully compiled statistics, the UK produced 258,800 first degree graduates and 11,000 doctorates. There were 54,000 other higher degrees awarded. On average there are 4.2 PhD's produced for every 100 first degree graduates. This is well over the 1 per cent we estimate is needed for replenishment of the academic profession, although the general appeal of academic salaries and conditions of service now causes growing concern. But for some disciplines, which compete head on with outside professions, there is a serious shortfall of research trained university and college teachers. We have identified a significant number of subjects—some with significant student demand at first degree level—with hardly any PhD output at all.

Taking Advantage of the Globalisation of Research

We consider that the UK science and engineering base is performing well on a global basis—in addition international collaboration is rising.

However, the global research base is becoming increasingly competitive; globalisation is shifting the headquarters of previously UK domiciled companies to other countries; and UK industry invests a lower proportion of its income on in-house research than industry in most other OECD countries, thus reducing its ability to "pull" from the research base. And, despite the dramatic increase in recent years, there is still some way to go before knowledge transfer activities are embedded in all HEIs at an appropriate level.

There are also structural problems to be addressed. In particular, an appropriate balance needs to be established between expenditure on projects and on the research infrastructure; and issues arising from human resources issues need to be addressed, particularly pay, career development and equal opportunities.

There is therefore no basis for complacency.

17 June 2000

APPENDIX 45

Supplementary memorandum submitted by Mr Colin S J McCarthy

First may I congratulate all those involved in the preparation of the White Paper. This is a well thought out and wide ranging review based on sound scientific and democratic processes. The comments I have made are intended to improve what is already a significant document!

The willingness of the Minister for Science to appear before the Science and Technology Committee and to attempt to address some of the concerns raised is welcome! The UK Government is now in the enviable position of having Foresight that has enabled the UK Government to be as well prepared as possible to exploit new technology and innovation. However, as "Stepping Stones to Sustainability by the Energy and Natural Environment Panel" (DTI December 2000) concurs, the biggest barrier to innovation appears to be vested interests and the perceived dominance of the private sector! With the world market for environmental goods and services expected to be £1,000 billion in 2014 radical action must be taken to stop global companies holding back the UK which at present is a leader in a lot of the new technologies.

By its very nature the White Paper covers parts of the economy that are performing well, eg ITEC, but others in traditional manufacturing sectors are failing and although less glamorous they also need attention and help to change where necessary. It is important that science and technology policy takes into account cross departmental issues; the availability of affordable housing, an efficient transport system and a social and commercial infrastructure that can cope with further expansion are often barriers to further development in the South East. It would be desirable to have the regional clusters and innovation section of the White Paper tackled as a priority. It is important companies accept the need to move to other areas of the country as physical location is often irrelevant in a global economy.

I think it is daft to believe that by creating an oversupply in the numbers of graduates throughout the country can solve temporary skill shortages in certain areas of the South East.

1. It is essential that the primacy of Westminster and Whitehall is preserved. MPs are democratically elected to represent the interests of their constituents NOT undemocratic global companies. It is essential that there is more democracy and transparency in large companies, especially as they often dictate conditions for SMEs.

2. Science Engineering and Technology are falling in popularity for students partly because they are difficult but also, because paper qualifications have been devalued, it is more important to have any pass at GCSE, A Level or Degree than it is a specific qualification. Students are also aware of parents, friends and relatives made redundant from science and technology based industries or who have insecure short-term contracts or have had to take early retirement. They therefore opt for having a good time now rather than investing in a quality science qualification.

It is also perceived that government and business only value business and management qualifications.

Apprenticeships and graduate apprenticeships may prove more popular. Long-term job security may still be possible if business management can be improved! However, there is oversupply of graduates at the moment and job satisfaction surveys reveal the most dissatisfaction for people who are overqualified for the job they are doing (if they can get one) and are unable to gain employment doing what they trained for!

3. Defence sector companies producing arms for sale to undemocratic countries with dubious human rights policies are not supported by the general population. The Ministry of Defence's recent decision not to reopen the inquiry into the Chinook Helicopter crash goes against scientific and democratic principles, which is especially disconcerting given the Public Accounts Committee findings. This highlights the need to modernise the MOD and military research to match a changed world political climate in which international organised crime is probably the greatest threat to democracy!

As a part of the British economy the defence sector does not perform well. A lot of projects attract large amounts of government funding for research, development and pre-production prototypes. Any foreign sales are usually supported by UK government export credit guarantees and when, as is often the case with arms sales, the customer does not pay it is the UK Government that foots the bill. This is of even more concern when the latest technology is finding its way to countries that the UK and its allies are in conflict with, or to international organised criminals.

The Government must understand that with an increasingly aware electorate it is politically unacceptable to have British weapons used on defenceless civilians or against British troops or their allies. The MOD should have as its priority defence of this country and its citizens!

4. Even if an offset deal is made for the payment of arms or defence technologies it has often led to unacceptable deals where British construction companies build dams in unsuitable areas and the consequent flooding of forests etc, cause very large releases of greenhouse gases from the decaying vegetation. The defence research carried out should be more targeted with prototype funding for products required for the UK or European and NATO allies. The overseas manufacture of products developed in this country should be discouraged. In a global market it is the skills of manufacture and development that are as important as knowledge. Information is more easily transferable across national boundaries.

5. When financial assistance in the form of grants, loans etc, is given to private sector companies more effort should be made to ensure the funds are used for the purpose for which they were intended. Any financial assistance should also take into account other government departments' legislation.

The accountancy profession in general and especially accountants working on behalf of the Government should be required to report any major inappropriate use of funds that are not clearly identified in a companies published accounts.

6. Investment in buildings, facilities and equipment at universities and schools is welcome but long overdue. However, universities should concentrate on speculative research and leave companies to do product development. Faraday Partnerships are welcome!

7. Climate change is now regarded as a major area for investigation and more funds need to be invested into solving climate change problems and to tackle urban regeneration and environmental problems.

Areas such as fuel cells and alternative green fuels are areas ripe for expansion. The Foresight process is a very good way of considering the details (if you can get the best people involved in it!) and the consultation document "Fuelling the Future by the Energy Futures Task Force" sets out a useful analysis of various R&D scenarios.

8. One of the biggest problems in the world economy is poor management. Most large companies have suffered from the external management consultant who has little knowledge of a company or its products, who comes in for a short period at a ridiculous pay rate, pronounces the need for drastic changes and then disappears leaving others to try to sort out the mess. It is also all too common for people with MBAs, and no science, engineering or technology background to use fairly powerful manipulative techniques to achieve a position of power and influence in a company but they do not have the technical ability to keep the company trading successfully. Managers often end up just following the latest management fashion for fear of losing their job if they question anything. The rapid turnover of staff also means research and development work is often repeated and more experienced older workers are the first to lose their jobs in any down sizing. Smaller companies are often dominated by large companies and can not act as freely or as independently as market analysts suggest. School students are often aware of this and do not choose to study a technical subject.

In order for bad managers to keep control they often prefer to employ less well skilled, but more compliant, foreign workers; either that or subcontract work abroad. If the Government stopped the excess numbers of foreign students and workers entering the country it would help remove bad management and also increase the amount of long-term sustainable employment! Business must be compelled to plan for the long-term and not to continually concentrate on short-term share price driven panic!

9. The DTI must be more active in its efforts to identify companies acting illegally; this may mean co-operation with other governments to deal with errant global companies. However, it may be more effective to ensure the public are kept well informed of bad companies as increasingly the consumer has the power to force big business to behave in a more responsible manner.

10. More effort needs to be made to ensure money allocated in the Science Budget produces long-term sustainable jobs for the UK electorate. Although we have to pay due regard to the global economy its existence should not be used to subvert parliamentary democracy we need to "Think Globally But Act Locally".

18 December 2000

APPENDIX 46

Memorandum submitted by Dr R D Worswick, Government Chemist and Chief Executive, LGC

1. INTRODUCTION

LGC is the UK's largest independent analytical laboratory. It occupies a unique position between the regulator and regulated, providing advice, validation, consultancy and research services to customers in both the public and private sectors. The company has a unique structure, with its shares jointly owned by the management and staff, 3i plc and the Royal Society of Chemistry (RSC). The RSC advises the Government chemist and DTI on the discharge of the Government Chemist's duties and monitors LGC's independence and quality of science.

With its headquarters in Teddington, and its North West base in Runcorn, LGC employs over 400 staff, including those in its subsidiary companies, University Diagnostics Ltd and Pipeline Developments Ltd. LGC also has European offices in France, Spain and Sweden.

The Government Chemist is appointed at LGC by the Secretary of State for Trade and Industry to fulfil specific statutory duties as referee analyst in cases of dispute, and to provide advice for government and the wider analytical community on the implications of analytical science for matters of policy, standards and regulation.

2. The 2000 Science and Innovation White Paper Focuses almost Exclusively on "Science Push" and takes too Little Account of the Industrial Situation and Dynamics

The origins of the White Paper in the Office of Science and Technology are all too clear in its emphasis upon the academic science base as the engine of innovation. The approach risks disproportionate emphasis on the supply side, and sails close to discredited linear models of innovation. It is disappointing that the strategy takes little evident account of the widely differing capacities of industry to respond to an increased drive from the science base. We have an innovation policy that addresses primarily the technically sophisticated companies, and even they are stretched to respond.

More help for universities to become drivers of innovation will be effective only if their skills in identifying potential for wealth creation are improved and if the other players along the innovation chain are positioned, resourced and prepared to be driven. The White Paper does nothing to counter the damaging bias of knowledge transfer schemes towards the supply side, and their limited reach. Current innovation policy takes insufficient account of industry developments (restructuring, delayering, globalisation) that influence receptiveness of the knowledge transfer message. There is room for doubt whether the new "Reach Out" fund will enable universities to find many new industrialists ready to grasp the helping hand. It is becoming increasingly difficult to find a receptive ear in delayered companies for a message about extramural innovation. Technically sophisticated SMEs with established relations with major companies and the science base are a soft target for innovation policy.

Again, business incubators and science parks are clearly effective for technically-based spin-outs, but they do little to foster innovation in established companies. There is, moreover, room for doubt whether universities are well placed to provide local technical support for any significant span of industry. The culture of science base training, often part time, for local industrial staff and close contact with local industrial requirements departed with the polytechnics; it has been replaced by one that values liaison with more technically sophisticated companies, wherever they are to be found.

3. Innovation in Measurement Science Merits Greater Attention for its Contribution to Industrial Competitiveness and Public Confidence

Few would dispute the priority for science policy of the greater pressure on material resources and the environment, for sustainable development, for sound science in responding to consumer and environmental concerns that threaten competitiveness, for priority accorded to biomolecular science and its underpinning disciplines. All these have clear implications for innovation in chemical and biochemical measurement. Science-based risk assessment is central in responding to consumer and environmental concerns within trade and competitiveness policy. Government's £38million annual expenditure on the National Measurement System was a striking omission from the 2000 Science and Innovation White Paper.

No fewer than 75 per cent of companies across the pharmaceuticals/agrochemicals, chemicals/petroleum, medical/health and food/drink/tobacco sectors declare that chemical and biochemical analysis is an essential business function. The turnover of the UK analytical business exceeds £7billion. It follows that innovation in analysis is an important component of the national performance. The declaration by Foresight that UK analysis was "lagging behind" stimulated activity to raise the level of play, through the Royal Society of Chemistry, EPSRC and DTI. It is important for Government to sustain and extend this new drive for analytical excellence in parallel with using it to drive innovation within the new strategy.

The requirement to secure wider innovation benefits from Government's R&D spending on defence has long been recognised, but there are opportunities too in departmental research programmes in health, food, safety and the environment. Risk assessment is commonly their focus and analytical science their cornerstone. It follows that the innovation most likely to be drawn from these programmes lies in analytical science, perhaps through novel operational approaches, instruments, test kits and sensors. The current pressure to keep regulatory science and advice clearly separated from industry could be seen as a barrier, but an initiative to improve the scientific support for risk assessment would be a valuable contribution to improving the public's perception of government's dealing with science. There is, similarly, significant potential for wider analytical innovation from Government's research into fighting crime. Drawing the Home Office meaningfully into a UK science and innovation strategy is a clear requirement.

4. Innovation Policy should take Greater Account of Research and Technology Organisations (RTOs) as Important Intermediary Players

RTOs can drive innovation more effectively than universities and yet the White Paper is silent about them. A broader industrial audience could be reached through knowledge transfer schemes delivered through RTOs, who have a clearer understanding of—and closer connections with—industry sectors than the science base. The examples of Germany and Holland show how effective intermediary organisations can be in this mode.

Intermediary organisations and consultants are more secure and credible sources of advice on technical processes and problem solving than universities. Independent market research commissioned by LGC shows that academic institutes were thought to provide added value to only 14 per cent of companies questioned.

Knowledge transfer clubs seem to have fallen undeservedly from favour in innovation policy, but have much to offer with good management and the use of IT.

The RTOs are also well placed to contribute to industrial training in technology, perhaps in collaboration with the science base. The Science and Innovation White Paper misses a trick in neither acknowledging nor seeking to capitalise upon their value.

20 December 2000

APPENDIX 47

Supplementary memorandum submitted by Professor D H Saxon, University of Glasgow

1. These are comments on the White Paper (Excellence and Opportunity, Cmnd 4814) and the Science Budget, 2001–02 to 2003–04. I shall concentrate on the effect on my own areas of interest, in the following capacities: Member of Council, PPARC (1997–); Member of Council, CCLRC (2000–), Head of Department of Physics and Astronomy, University of Glasgow (1996–).

2. There is much that is very good in the Science Budget. I welcome the timely initiative in e-science. But CCLRC still faces problems if it is to be able to continue to deliver the excellence in facilities and expertise that it has in the past.

3. For PPARC the uplift in the baseline is earmarked. For astronomy this is understandable as the approach to ESO will provide some change of direction, and it is right that some pruning should occur. But in both astronomy and particle physics inflation will damage very good science outside the earmarked area. The flavour of under-funding and is by no means eliminated. One particular disappointment was in hopes for accelerator R&D. PPARC attaches some importance to this and hoped to see it addressed in the CCLRC line, but this has not yet happened.

4. CCLRC is presently in a difficult position. The White Paper (chap 2, para 18) states that previously "CCLRC was not given a clear mission or proper funding arrangements; we should now do so." As a Council member I heartily agree. We are waiting expectantly for the publication of the quinquennial review of CCLRC held earlier this year, and the Government's response. Meanwhile we are losing time because of the uncertainty created.

5. The seed money for new projects offered in the Science Budget to CCLRC is at too low a level. Whilst the increase is welcome, the total falls well below the 5 per cent of turnover necessary to prepare for future investment. The objectives for CCLRC listed in the White Paper include "develop the core competencies and other capabilities that can contribute to the nation's science and technology base." We need to see a little more resourcing here to deliver on this.

6. The delay in setting up the management arrangements for Diamond is becoming damaging. The Science Budget refers to "secondment of key UK design expertise from CCLRC at Daresbury to the Diamond project team." Staff are eagerly asking CCLRC management what the arrangements are. At present it is difficult to explain to them why they should not take offers from abroad. Four experts have left to date.

7. I have referred to the disappointment over accelerator R&D under PPARC. CCLRC is a natural location for this as this technology increasingly underpins a range of applications from Higgs Boson hunting via materials science and biology to hadron therapy for cancer. Hopefully, the arrangements to be put in place following the quinquennial review will allow this to be addressed.

8. At the university level, SRIF is very complimentary to JIF. JIF involved massive form-filling and had a success rate barely over 10 per cent, (with consequent massive waste of effort,) but has funded some excellent initiatives. SRIF devolves the competition to within each university and will allow each university to take a strategic look at its own priorities.

9. The main worry for the future of university research must now be the uncompetitive level of salaries. We currently offer a 27 year old, with a Ph D, £18731 per annum. Yet our 21 year old Hons B Sc graduates frequently get offers over £20K. Over the last few years I have watched our RAE grade 5* computer science department get raided for staff by industry along with our grade 5 Electrical and Electronic Engineering department. In the last year the same process has started in particle physics. It is the future leadership that is going. We are building up long-term problems unless this is addressed.

10. The core funding of universities is simply too weak. University lecturers are expected not only to teach larger numbers of students than previously, but during the vacations to start up and to deliver on initiatives in research to the level of £120K per head per year (in my department). Even with overhead-bearing income at this level, and growing, it is an annual battle to maintain solvency, in spite of vigorous restructuring in the last two years.

11. Finally, I note that the report "International Perceptions of UK Research in Physics and Astronomy" drew attention to the recent drastic decline in the number of physicists entering post-graduate teacher training courses. The position is masked by the number of biologists entering science teaching. Physics as a discipline

underpins much of engineering and technology. The trend to combined science in schools is tending to marginalize the subject, and this is where the greatest long-term danger lies.

19 December 2000

APPENDIX 48

Supplementary memorandum submitted by the Royal College of Veterinary Surgeons

We welcome the opportunity to comment on the White Paper "Excellence and Opportunity, a science and innovation policy for the 21st century". We do so in the context of our earlier submission (9 June 2000). This emphasised:

(1) Veterinary science as an area of national research strength.

(2) The importance of veterinary science not only to the patients but through its role in sustaining the network of SMEs represented by general practices, the jobs which they create directly and through the various support industries. All of this depends on research if it is to keep pace with the advance in public perceptions and public demands, as well as the needs of animal health and those affected by it.

(3) The key role for veterinary research through its relevance to public health and comparative medicine, ie the insights into human disease which can be gained from relevant models in domesticated species, notably dogs and cats. Closer alignment of the research interests of human and veterinary medicine has been a key objective of this organisation in recent years.

(4) Concern that, in view of the importance of the Foresight programme in the national scientific research strategy, veterinary medicine should feature alongside human medicine in its deliberations.

While there is much to welcome in the White Paper in general terms, the lack of involvement of veterinary research gives cause for concern. Indeed this seems to mirror a serious gap in the recent report of the Healthcare Panel ("Healthcare 2020"). This omission was the subject of the very pertinent Editorial in the Veterinary Record of 16 December (page 697) and it is not consistent with the priorities identified in the 1995 Report of the Foresight Health Sciences Panel nor with the role for Foresight properly envisaged on page 26 of the White Paper.

The question of public trust of scientific evidence concerning risk, including the risks potentially arising from scientific innovation, is addressed on page 5, also pages 50–51. In the veterinary context, key areas are zoonoses, antimicrobial resistance and food safety. It is disappointing that the primary organisation responsible for the latter, the newly created Food Standards Agency (page 54), has so little veterinary experience represented in its senior appointments. Eventually, this could prove a serious weakness.

The appreciation of the importance of financial support and career structure in attracting elite talent into research (pages 9, 12, 23) is essential; without such talent truly innovative research cannot flourish.

The role of the research councils, particularly the MRC, is addressed on pages 19 and 54 with particular emphasis on interdisciplinary research. The MRC has recently established a Comparative Clinical Science Panel to foster research links between human and veterinary medicine, provided that adequate additional funding can be secured. Rather than attempting to secure these funds through appeals and donations, it would add greatly to the momentum and effectiveness of this very welcome initiative if the additional funds could be made available to the MRC through specific allocations in the new Science Budget. The benefits to both human and veterinary medicine would be huge compared with the investment involved (£10m pa) and would go a long way to providing the strategic focus for veterinary clinical research—the lack of which was one of the main findings of the Selborne Report on Veterinary Research (1997). It would greatly enhance the ability of one of our areas of national competitiveness, veterinary science, to meet the needs of the new century, in particular a strong evidence base for clinical decisions.

8 January 2001

APPENDIX 49

Supplementary memorandum submitted by the Association of Veterinary Teachers and Research Workers

Unfortunately, at a time when careful and constructive political attention is being devoted to science in general, veterinary science, which although small, is being marginalised despite the fact that it attracts the very highest calibre of our science-motivated school leavers and features among our areas of international scientific strength.

1. The key issue identified in our earlier submission was the position of veterinary science within the Foresight programme. Our fears have been amply confirmed by the launch of the Healthcare Panel's 2020 Report and the discussion at the launch meeting at the DTI on 5 December. The Report makes no mention of either veterinary science or comparative medicine and when a member of our Council asked the Chairman about this his reply was "to be honest, I don't think we discussed it". This is particularly disappointing in light of the 1995 Report of the Health & Life Sciences Panel which stated that "Judged against the UK's average activity in all disciplines, we have a particularly strong presence in pharmacology, immunology, genetics and veterinary science" and the particular importance which was attached to "comparative medicine and veterinary pathology".

Veterinary pathology has been in crisis for the last decade and comparative medicine is now at a moment of unique opportunity, through the MRC's initiative in establishing a Comparative Clinical Science Panel, subject to satisfactory funding. The attached Editorial from the Veterinary Record of December 16 is self explanatory*. The White Paper [p10, paragraph 35] rightly emphasises the importance of "getting the best ideas from Foresight 2000 put into action fast". Yet veterinary science seems to have been orphaned from this key instrument of strategic planning to maximise the public benefits accruing from scientific research—benefits to human health and animal health which would flow from reinforcement of our national strengths in veterinary science and comparative medicine. In this specific area, "priorities identified in the first Foresight reports in 1995" [paragraph 3, p26] have slipped out of sight and as a result we will not capitalise on one of our areas of genuine international competitiveness [paragraph 20, p18].

2. Paragraph 3 [p26] emphasises the central role of Foresight in integrating different aspects of our national skills-research, industry, policy making etc to increase national competitiveness. A key area of our national enterprise is to maximise the success of Small to Medium Enterprises (SMEs). The veterinary healthcare network is precisely this—a chain of successful SMEs built upon a rapidly evolving set of exportable technologies. Both the expansion of the internet and relaxation of movement controls on animals present growing opportunities for international collaboration. Each veterinary graduate is the basis for job opportunities for a range of support staff, and each veterinary practice is part of the market for a wide range of support industries in diagnostic imaging, automated analysis, information technology, pharmaceuticals, surgical equipment etc. Indeed, the best veterinary practices set an example of healthcare delivery at local level which the NHS has yet to emulate. The White Paper [p4, paragraph 11] rightly emphasises the key role for Government in ensuring that there is the climate for innovation to flourish and for progress to be sustained. However nothing in the White Paper even glimpses the need to cultivate our strengths in veterinary science and to engage them in our national strategy, for the benefits of humans as well as animals, for welfare and for commercial success. Veterinary science is precisely one of the areas in which this country has "a remarkable record of world class research" [pi, paragraph 4] but in the subsequent words of the Secretary of State's introduction "excellence is only the start. It is not enough to generate research—we also have to make the most of it".

3. The Selborne Report of 1997 rightly identified one of the problems of veterinary research as being the lack of a strategic funding focus, especially for clinical research. The MRC was identified as one logical means of meeting this need, a view shared by this Association and the British Veterinary Association in its submissions to the Selborne Committee of Enquiry. We are pleased to report progress on this front with the agreement of the Council of the MRC (subject to satisfactory funding) to establish a "Comparative Clinical Science Panel" which will serve to:

(a) Maximise collaborative research between medical and veterinary clinical scientists.

(b) To exploit the opportunities to draw lessons concerning the causes, diagnosis and prevention or treatment of human diseases by studying the equivalent diseases among veterinary patients; these opportunities are especially important with multifactorial diseases (which are inherently difficult to model), also with diseases of shared environments, and with zoonoses.

(c) Raise the quality of veterinary clinical science and strengthen the evidence base for veterinary medicine.

(d) Directly involve practitioners, alongside laboratory scientists, in the planning and conduct of the research, and attract some of the brightest veterinary graduates to engage in research, alongside their clinical careers.

This initiative relates directly, therefore, to the Government's objective in minimising the distance between identification of need, implementation of necessary research and delivery of benefit.

At the moment the activation of the Panel rests on the ability of the veterinary enterprise to raise the requisite funding for an initial trial period of five years [£10 million pa]. The reason for this was to prevent public or political criticism of the initiative on the grounds that it "diverted funds from humans to animals" whereas the intention is to benefit both. It would enormously accelerate the implementation of this excellent scheme if the costs could be met by an additional allocation to the MRC budget for this purpose, alongside the other additional allocations [Science Budget, p17]. It is a prime example of an initiative to foster interdisciplinary research [paragraph 22, p19].

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*Not printed.

4. We welcome the emphasis on the need for academic careers to be rewarding if we are to attract and retain the brightest and the best [p12, paragraph 3]. While salary improvements are important [p9, paragraph 32] a veterinary graduate who follows a career in good quality practice, may, after five years, achieve a salary above the professional average, let alone the stipend for a post doctoral Fellow. It is essential therefore to ensure that research careers are "rewarding" [p12, paragraph 3] in a broader sense. In particular there must be some sort of career structure and reasonable security for those who perform well, as emphasised in paragraph 34, p23.

5. Turning to some broader issues, we welcome the affirmation [paragraph 38, p11] that "the market alone will not generate the basic investment in research". This is true of clinical investigations where no one company necessarily has a product benefit—eg nutritional change may be more beneficial than drugs, or multiple interventions may be needed for prevention. But it is also true of developing countries which may have enormous needs but slender resources to do the necessary research or purchase the requisite outcomes. A key factor in both health and wellbeing remains the ability to produce sufficient food of sufficient quality. In particular, there are areas, for example in Africa, where the environment is such that food production is always likely to be costly and require inputs which are ultimately environmentally damaging, compared with regions where the same food can readily be produced more efficiently. This requires a global view of the balance between production and need of the research required to optimise it; the necessary progress will not be achieved if it is left to market forces alone, nor if we are constrained by a purely EU view of supply and demand. While it is vital to maximise our opportunities to generate business from our science base [paragraph 20, p6] we have ethical as well as commercial responsibilities in harnessing our scientific expertise. "We need to make certain that all regions benefit from the development of new products and processes", we have global responsibilities, as well as being "in a global competition". [paragraph 23, 25, p8].

6. The issue of public confidence and political judgement of risk [paragraph 16, p5] is fraught with difficulty and quite different standards seem to apply to food scares or zoonoses, compared with mobile phones or component failures in widely used aero engines or aircraft. Evidence-based reassurance of consumers [paragraph 16, p50] is not helped by the fact that scientific employees engaged in non-military research based in Government establishments are bound by the Official Secrets Act. Indeed it is perhaps fortunate that few members of the public realise this constraint. Regarding the vital role of the media [paragraph 17] objectivity is not helped by having a growing proportion of TV output from independent commercial programme makers; their paramount interest for survival, like that of newspapers, has to be for what sells and what does not offend important advertisers. As a result there is an appetite for oversimplification, at best, to sensationalism at worst. Neither helps with issues which frequently turn on the balance of probabilities. A particular example of these difficulties is the contrast between the tight regulatory requirements to substantiate claims of efficacy and safety for conventional medicines and the lack of comparable safeguards with regard to complementary remedies—or of the necessary research. The current faith in these remedies is mostly based on anecdotal evidence and media enthusiasm, rather than evidence of the quality demanded of conventional medicine. This is true of both human and especially veterinary medicine. Who should be responsible for such research is a moot point, granted that the likelihood of negative outcomes is high.

7. The need for universities and others to learn from one another [paragraph 39, p44] is properly emphasised and the closer links between the Veterinary Laboratories Agency and the veterinary schools are consistent with this objective as is the initiative outlined in paragraph 3 above.

8. Paragraph 35 *et seq,* p24. There is no better example of a scientific career in which women have flourished than veterinary medicine, with the huge majority of students and recent graduates now female, and the tendency to remain professionally active even after assuming responsibility for children.

9. Paragraph 8 p14. The need to promote science to children is paramount as is the need to enable them to realise that research is the engine of progress, not a threat to future generations, or to the environment or to animals. There is no area of applied science which attracts the public, particularly children, more powerfully than veterinary medicine. It provides the ideal opportunity to build on an instinctive affinity, rather than instinctive suspicion, and to emphasise the link between scientific progress and benefit to future patients, both human and animal. But to do so, it has to continue to advance and we have reservations, as already expressed, that at present there is insufficient concern to sustain its momentum within the national science strategy.

8 January 2001

APPENDIX 50

Supplementary memorandum submitted by Imperial Chemical Industries Group plc

There is much to commend in the objectives of the White Paper.

ICI strongly supports investment in the academic science base, as this is very much the engine for future (longer-term) growth potential. We would caution funds allocated for infrastructure renewal are "selectively" allocated, perhaps taking account of REA ratings in order to ensure that we maintain and enhance our world-class establishments.

Increasing the PhD stipend is a sound move and should go some way towards encouraging British students to pursue post-graduate training.

The move to provide funding to attract top researchers in to UK academia is laudable; however, it is not clear how this will be handled within the existing infrastructure. Will the funds go towards enhanced salaries or to assist research activities?

We strongly support the move to provide a more focused approach to career development for fixed-term contract researchers.

ICI has over the years assisted in the non-vocational training of university researchers working on collaborative projects with the company, eg CASE students, teaching company associates and sponsored post doctoral fellows. We would be pleased to make some of our training material more generally available.

The proposed Science Ambassadors programme will undoubtedly receive support from our UK based science and engineering professionals. Many have been involved with the BAAS and the neighbourhood engineers programme over the years.

ICI has since its foundation in 1926 worked closely with the academic sector and prides itself on the mutual trust between company researchers and their academic collaborators. This has largely been in the area of basic underpinning science and technology.

The introduction of the Higher Education Reach out to Business and the Community seems to offer potential for universities to carry forward projects to "proof of principal" stage and we look forward to identifying opportunities for ICI to further engage with UK universities. We will also address the specific support to SMEs through promoting as appropriate through our supply chain network.

The creation of Foresight generated tremendous energy across the industrial/academic sectors and helped considerably in developing an improved mutual understanding of "needs and deliverables".

It is good news therefore that a new Foresight fund is to be launched. However, £15 million seems too little for investing in the target areas identified by the "Foresight community".

As we stated in our submission to the Common's S&T Committee on "Are We Realising Our Potential"

> "The reports produced by the individual Foresight panels and the overview summary report were exemplary and established an excellent platform for investing in the science and technology of the future. However, I would suggest that the level of investment is still rather short of that anticipated through the first Foresight phase. I take as an example, the highest priority identified by the Chemicals Panel, ie creation of a "Centre for Applied Catalysis". This was granted a Foresight Challenge award of £3m over 4 years. Hardly world-class?"

Increased funding for Faraday Partnership is welcomed as we see this as a means to developing an applied research centre network in the UK akin to the Fraunhofer Society in Germany. This greatly facilitates University to Industry technology transfer (and subsequent commercialisation).

8 January 2001

APPENDIX 51

Supplementary memorandum submitted by the Natural Environment Research Council

THE WHITE PAPER

NERC welcomes The White Paper and the recognition by government that a healthy and vibrant science base is an essential component of a successful knowledge driven economy.

Chapter 2: Excellence in Science is well balanced in that it addresses the need to attract school children into science, the provision of adequate funds for infrastructure and priority science areas, through to attracting and retaining top researchers in the UK. NERC welcomes the increase in PhD stipend (chapter 2, paragraph 33).

NERC welcomes government initiatives designed to promote innovation in chapter 3: Opportunities for Innovation. Whereas the emphasis on universities and regions is understandable it should not be forgotten that public sector research establishments are also part of the science base and that industrial sectors transcend regions.

The Small Business Research Initiative is a new departure for the research councils (chapter 3, paragraph 33). Whereas NERC will endeavour to procure 2.5 per cent of its research from small business, it must be recognised that this will divert resources from universities and NERC research centres.

NERC welcomes chapter 4: Confident Consumers. The move towards more openness and transparency is essential. NERC is taking steps to ensure its decision making processes are more transparent and now works on the presumption that information should be open rather than confidential. NERC has also revised its science and society strategy with a view to developing a more consultative approach about priorities.

THE SCIENCE BUDGET

The process and outcome of the Science Budget should encourage greater cross-research council working, which we welcome.

The increased Science Budget to NERC resulting from SR2000 is welcome. However it will not allow us to meet all of our current priorities. Some difficult decisions lie ahead. Although NERC will continue to fund the very best research through its responsive mode funding stream, it recognises the need for strategic research targeted at specific areas. NERC will play a full role in delivering SR2000 priorities relating to the genome, e-science and basic technologies. It will promote cross research council approaches to these and other areas including technology for sustainability and energy. The speed at which NERC can deliver on new programmes is limited by the ability to recycle funds from existing activities. The Council is actively looking at ways to increase our financial flexibility.

9 January 2001

APPENDIX 52

Memorandum submitted by the Council for the Mathematical Sciences

We are pleased that the outcome of the recent public spending review has resulted in the continued favourable treatment of science funded by the DTI. We hope similarly favourable treatment will be forthcoming for research funded by other ministries. We are sure that you will understand that our concern is for mathematics and the health of our subject in the broadest sense. We particularly welcome the increasing evidence of the acknowledgement of the importance of mathematics both in its own right and in an underpinning role across the whole of science and technology; particularly of the role that mathematics can play in wealth creation in the UK.

On this underpinning role, we would bring to your attention the first paragraph of the Objectives of the Mathematics Programme of EPSRC, (see: http://www.epsrc.ac.uk):

> "Mathematics is a pervasive discipline that underpins all other disciplines and contributes to advances made in them for the benefit of their user communities. New developments in other disciplines can lead to novel mathematical approaches, while unifying concepts in mathematics bring together apparently diverse applications in different fields. Mathematics is therefore a vital component of a healthy science and engineering base."

We have noted with satisfaction the increase in the EPSRC mathematics budget of 85 per cent over three years, even though this was from a very low initial base. We believe that it will be necessary to continue this rate of increase in the future, if mathematics is to play its essential supporting role to the development of other sciences and technology.

9 January 2001

APPENDIX 53

Memorandum submitted by the Institution of Mechanical Engineers

We welcome the Government's recognition that scientific excellence is only part of the wealth creation and quality of life enhancement processes. We welcome its emphasis on helping manufacturing and service companies to innovate and adopt new technologies. We support the view that to be a successful nation we must have the facility to quickly transform scientific discovery into useful products and services. Successful exploitation will create the wealth that is required to improve our society and sustain our scientific endeavour.

We are concerned, however, that the Government does not fully appreciate or understand the vitally important role of engineering in the innovation process and the successful exploitation of scientific knowledge. The White Paper strongly indicates that it is excellent science that automatically leads to innovation and market success. Whilst it is the work carried out by scientists that produces new knowledge and understanding of what exists, it is the combination of this with engineering knowledge through the process of "engineering" that transforms such knowledge into commercially successful, useful products and services.

It is this successful exploitation of scientific knowledge (ie innovation) that has long been a major weakness within the UK's economy. As a nation, we have long been very good at invention, but much less effective at innovation. We broadly support the view that the Government, and business, should do far more to support the Science Base and its basic research. However, when we contrast the UK's performance with that of other technologically advanced countries we believe that far too little is being done to encourage a greater take up of engineering within schools and universities and corresponding investment in engineering research and facilities within universities and industry. It is only by such encouragement that we will get the much needed flow of high quality engineers and innovative products and services into all areas of the UK economy, and begin to close the competitiveness gap that is growing between the UK and other nations.

Much as we welcome efforts to improve the links between universities and industry, we do not accept that universities alone can be expected to turn scientific knowledge into national wealth. That is a role for all organisations in the knowledge economy, and in particular those most familiar with the needs of global markets, and they will all need more professional engineers to make it happen.

For this to occur there needs to be a cultural change across society. It will no longer be appropriate to think of science as embracing engineering and technology. Instead we must more proactively encourage innovation and the exploitation of knowledge through professional engineering. We therefore suggest as a first step that government appoint a Chief Science and Engineering Advisor to guide government policy and strategy on the future focus for scientific research and its exploitation to improve national wealth.

10 January 2001

APPENDIX 54

Supplementary memorandum submitted by the Bolton Institute

As outlined in my response to the consequence of the 1993 White Paper—Realising Our Potential, any comments are made within the context of a small-to-medium-sized higher education institution that undertakes applied scientific and engineering research concentrating upon regional company interactions. As stated in our earlier memorandum, the previous White Paper benefited our work and plans because of the recognition of the SME sector and its need for support by OST funding sources, in particular. In addition, the Foresight technology process has provided a catalyst to this and has significantly influenced our industrial S&T direction and funding.

SCIENTIFIC EXCELLENCE

The present White Paper is a logical extension of its predecessor and rightly focuses on the need to promote scientific excellence. To attempt to attract more young people into science ("Science Year 2001–02") is to be applauded as is the decision to raise postgraduate support for new science and engineering graduates who otherwise may be dissuaded from proceeding to postgraduate research training.

However, two major decision-assisting factors for young people are missed by the paper. These are:-

- the improved remuneration for science, maths and technology teachers in schools, to attract the most highly talented graduates into the profession, and
- the perceived value placed on science and engineering by young people.

UK society, in spite of its history of producing world class scientists and engineers, does not value them as highly as other professionals such as doctors, accountants and lawyers. In Germany and France, for example, they are more highly valued. This view by the young in particular, is partly a consequence of their relatively poor earning potential whether real or perceived. Talented teachers and initiatives like "Science Year 2001–02" will excite young people but their decisions to pursue a scientific or engineering career is largely based on expected earning potential. It is well known from remuneration surveys (eg The Royal Society of Chemistry) that practising scientists and engineers are paid less than those pursuing non-practising careers and most will be paid less than doctors, lawyers accountants and members of financial houses. What is the White Paper doing to address the value that UK Society places on its scientists?—It is silent!

The decline in graduates in these disciplines, highlighted in the White Paper, will only be reversed if status and value (and hence remuneration) by society are enhanced. It will probably be seen in the immediate future that student debt will exacerbate this "drift away from science"—where are the "golden hellos" being offered to scientists and engineers—not from industry or public employers but from the commercial and especially financial sectors where their talents are more fully recognised?.

INNOVATION

We note that the White Paper identifies that the "knowledge-intensive" sectors account for 38 per cent of the value of the London Stock Exchange for 1998. It proposes that these high technology sectors should be the focus of our activities. Little or no mention is made of the other (and larger) 62 per cent which probably contains the majority of the so-called traditional wealth-creating areas many of which (eg chemicals, aerospace, etc,) are still knowledge-intensive. They also employ the majority of our present scientists and engineers. Does the White Paper propose that we should neglect these areas? It is noteworthy that the USA and EU member states are all focusing upon this same 38 per cent (as indeed are some of the so-called developing nations)—competition will be immense and is the market large enough? Surely, elements of the remaining 62 per cent should now be seen as niche opportunities for the UK (since our competitors no longer appear to be interested in them)? It is interesting to note the importance given by the White Paper to nanotechnology; I would suggest that chemists were the first nanotechnologists and that they still remain in the van of modern developments in this "new" discipline. The White Paper and the London Stock Exchange do not realise or wish to acknowledge this, however.

Innovation cannot happen without a renewable human resource having excellent educational backgrounds in science and engineering. It is interesting that while the White Paper announces £1 billion in partnership with the Welcome Trust for infrastructure, only £140 million is being announced for the HE Innovation Fund. The former will fund the traditional university sector (as did the previous £1 billion) which probably interacts to a limited extent with regional communities and local SMEs. It is hoped, although unlikely, that most of the £140 million may be focussed upon the newer universities which have the better record of serving their regional and local communities. Taken as a nationwide figure, I would suggest that this will add only marginal value to present HEROBC initiatives. Furthermore, if it is to be distributed within the current "bid philosophy" then the administrative costs will once again be borne by the HE community; its attractiveness will be influenced by this factor.

In conclusion, while the White Paper offers some good news, especially with regard to some improved regional and small business funding, it will not change the drift away from science of young people in spite of improved "A" level performance in schools across all subjects. It is interesting to note that the engineering professions in attempts to raise the status of engineers have merely driven up the minimum "A" level point requirements for students entering accredited engineering courses. This has had the following effects:-

(i) it has helped reduce the numbers of total BEng students entering accredited courses;

(ii) it has produced closures of engineering departments;

(iii) it has virtually closed down part-time higher educational routes on accredited courses.

Had the professions attempted to raise the stature and remuneration of their members, then different and most likely reverse trends might have been seen. The Government is in a position to significantly influence the culture of UK society towards its scientists and engineers and it is unfortunate that the White Paper does not address this issue at all.

10 January 2001

APPENDIX 55

Supplementary memorandum submitted by Novartis Pharmaceuticals Ltd

1. INTRODUCTION

Novartis is a global leader in healthcare and is committed to improving health and well-being through innovative products and services. As a pioneer of research into emerging technologies, Novartis supports science and innovation, investing more than £1.5 billion annually world-wide.

This memorandum addresses the following areas as discussed in the DTI White Paper, "Excellence and Opportunity", and outlines the ongoing contribution of Novartis in these areas:

(I) Active promotion of public confidence in science to improve public acceptability of new technologies.

(II) The ongoing development of new and innovative technologies.

(III) Considerable capital and non-capital investment in science.

(IV) Willingness for public/private sector partnership to advance scientific understanding.

(V) Importance of maintaining a positive research environment in the UK.

2. PROMOTING PUBLIC CONFIDENCE IN SCIENCE

Genuine public debate is crucial to the acceptability of new scientific developments. There is continuing need therefore to find appropriate forms of dialogue that will help bridge the gap between scientists and the public. Novartis believes that it is the responsibility of scientists, research establishments, governments and NGOs, as well as companies like Novartis, to promote public confidence in science and innovation.

Channels of Communication

Consumer confidence in science invariably depends on how well the public understands science and, in particular, newer technologies that are unfamiliar and for which the implications are unclear. Novartis is committed to open communication about their business, addressing the risks involved in the use of modern science as openly as the benefits (see examples in "Novartis Response to the Science & Technology Committee's Inquiry into the 1993 White Paper "Realising our Potential"). The quality of an informed public debate can be improved by involving key groups in this process.

The media play a very crucial role in informing the public, setting the agenda and building public perceptions about science. The exchange of information between scientists and the media is crucial to ensuring constructive dissemination of information to the public ultimately. Novartis brings together scientists and the media to improve this exchange and continues to develop productive relationships with both groups.

The Internet has an important role to play in the dissemination of information to the public. Novartis encourages and supports academic institutions in publicising their websites, making them more user-friendly and aimed at improving public understanding of science.

As part of the company's commitment to the use of the Internet as an innovative way of teaching science, Novartis hosted a live "Science Webcast" of two scientific experiments transmitted into school classrooms in 2000.

Scientists have an important role to play in explaining science to the public in a way that will improve public understanding of science.

Together with the Institute of Biology, Novartis has provided a number of scientists with media training. This training allows scientists the opportunity to rehearse effective communication of science through modern media such as television and radio, in a way the public will understand.

Novartis also supports the British Association in a variety of activities and "Scientists for the New Century", a monthly lecture series presented by the Royal Institution and *The Times* newspaper. The lecture series aims to bring Britian's emerging scientists to the attention of the general public and every month in 2000, a speaker delivered a lecture about the cutting edge science being undertaken currently in Britain. In order to give younger scientists opportunity to shine, all of the lecturers are under 40 years. In 2001, this lecture series will continue and eight scientists will be chosen to speak on the basis of academic excellence and their ability to communicate.

Another Royal Institution activity Novartis supports is a medical lecture series at the Royal Institution where the public are invited to question doctors and scientists about the latest developments in life threatening conditions.

The Novartis Foundation

Dialogue among scientists is essential to advance scientific learning. "The Novartis Foundation" with premises based in London, is a forum where scientists from all over the world can exchange their knowledge and ideas. Every year, the Foundation organises numerous scientific symposia, which are subsequently published in book form.

Support of Charities/Patient Organisations

Charitable organisations and in particular, patient support groups, play an important role involving patients in the delivery of effective healthcare. By communicating reliable information that patients understand, support groups empower patients to take responsibility for their health. Novartis supports a number of charities including the Parkinson's Disease Society and the National Kidney Foundation.

3. New Technologies and Innovation

Novartis' core businesses are in pharmaceuticals, consumer health, generics, eye-care and animal health. Novartis invests over £1.7 billion globally each year in research and development (R&D). We are one of the leading companies in the world for investment in R&D.

Developments in Biotechnology and Genomics

Modern biotechnology, and especially gene technology, is indispensable to modern biomedical research. Its application can be used for the prevention, diagnosis and treatment of diseases. The use of gene technology has already led to progress in treating cancer. Novartis is looking at using biotechnology, in collaboration with outside partners to gain insights into the processes of viruses, bacteria and cells, to understand the causes of specific human diseases and their possible genetic links and to help introduce specific genes or knock out existing genes to correct certain genetic processes.

We are committed to three key principles in our use of biotechnology: it must be safe, it must bring benefits and it must be used in a responsible manner.

Pharmaceutical Development

March 2000 saw the launch of a new anti-epileptic drug from Novartis in the UK. It represents the first anti-epileptic drug approved for first-line use in the past five years and offers hope to newly diagnosed patients and those who cannot achieve satisfactory control with current treatments. It is more convenient for patients to use and simpler than current treatments.

Planned soon are new treatments for diabetes, irritable bowel syndrome and eczema for which regulatory approval is currently awaited. A new asthma treatment is also due to be introduced this year.

Joint R&D partnerships with third parties, individuals and universities are also important to progress in the development of pharmaceuticals. Collaboration between Novartis and the Royal Free Hospital contributed to the development of Simulect, an important drug to assist in successful organ transplantation.

Developments in Consumer Health

Novartis Consumer Health is a world leader in the fast-changing consumer health market, and focuses on over-the-counter (OTC) medicines, medical nutrition and health and functional nutrition.

As well as projects in nutrition, a new programme has been established to help discover and develop proprietary and novel ingredients, which has found promising leads in the therapeutic areas of pain/inflammation, immune systems, cardiovascular and lifestyle management.

Innovations in Eye Care

Through innovations and quality in contact lenses, lens care products, ophthalmic pharmaceuticals and ophthalmic surgery, CIBA Vision, a Novartis company, has pioneered many advances in eye care. Products are sold to consumers and eye care professionals in the UK.

Visudyne therapy, the first effective treatment for age-related macular degeneration (AMD), was recently launched in the UK. This is a new treatment that helps prevent the most frequent cause of blindness amongst people over the age of 50.

Novartis research provides CIBA Vision with new chemical entities for future products, new applications for existing designs and access to the latest developments in biotechnology. These resources are complemented by licensing agreements and joint R&D partnerships with third parties, individuals and universities.

Working with Novartis Pharmaceuticals, CIBA Vision is exploring anti-angiogenesis to treat diabetic retinopathy and neuroprotectors to treat optic nerve diseases such as glaucoma. Phase III clinical trials for Rescula, a new glaucoma treatment are also under way in the US. In addition, an artificial cornea and an accommodating lens with the potential to delay the onset of presbyopia are in development.

4. Investment and Funding

In the UK alone, Novartis is spending £1 million every week on pharmaceutical research.

Novartis has a current capital investment programme of £100 million to develop key research and manufacturing facilities around the country, including London and Grimsby.

Novartis is establishing a £40 million world-class centre for respiratory research in Horsham, West Sussex which will be one of the largest single-site research groups in the world dedicated to this therapeutic area. The centre will also host international pre-clinical and clinical operations for other therapeutic research areas. Each major step of the pharmaceutical product development process is undertaken at Horsham, from compound discovery and research right through to manufacturing.

The investment in new, state of the art facilities attracts international scientists to employment in the UK.

5. Private/Public Sector Partnership

Public/private sector partnership is an important part of maintaining the excellence of the Science Base in the UK. These external relationships widen the sector's scientific and technological capabilities as well as improve access to new discoveries. Drug discovery, for example, nowadays requires the involvement of a wide range of disciplines. To complement Novartis' own in-house efforts the company is establishing links with groups that have particular expertise in platform technologies—areas of expertise that provide the basic scientific input into drug discovery—such as genomics, combinatorial chemistry and high-throughput screening.

Novartis supports emphasis in the guidance for the next RAE (Research Assessment Exercise), in 2001, that basic and strategic research done in confidence for business should be given equal weight alongside papers published in peer review journals.

Collaboration with Academic Institutions

It is important to encourage the ablest people to engage in science in Britain. Novartis makes a considerable investment in collaborative industrial studentships organised through research councils including the Medical Research Council (MRC) and the Engineering and Physical Sciences Research Council (EPSRC).

Novartis collaborates with a number of institutions in the UK to research respiratory disease and also supports "Link Awards" where together with research councils, the company provides funding for broader research at universities across the country.

Collaboration with the NHS

Novartis supports hospital research teams by meeting the salary requirements of research posts in major centres of excellence.

Collaboration in clinical research is increasingly difficult in the face of significant overhead charges and slow approval processes with MREC forcing Novartis to seek liaison with other countries.

6. IMPORTANCE OF MAINTAINING A POSITIVE RESEARCH ENVIRONMENT

Three key environmental factors influence the suitability of the UK as a research base;

Skilled Labour

The UK has traditionally cultivated a prosperous science based through investment in science education. It is important to maintain this pool of labour to retain pharmaceutical company activity in the UK.

Stable Regulatory Policies

Improved timeliness, ethical approval processes and start up times for trials is vital to maintain a strong research base.

Freedom of Threat from Anti-science/Animal Activists

Delays in approval for animal research and attacks on research establishments are reducing the viability of the UK as a research base. This situation must be improved.

APPENDIX 56

Supplementary memorandum submitted by The Centre for Urban and Regional Development Studies University of Newcastle upon Tyne

INTRODUCTION

1. In 2000, CURDS submitted a memorandum of evidence to the Commons Science and Technology Committee Inquiry "Are We Realising Our Potential?". The central thrust of that memorandum was to illustrate the weaknesses in the UK's system of scientific governance which inhibited regional representation into Science Budget decisions. The case of Daresbury was used to illustrate how this meant that decisions ostensibly taken in the best interest of the UK could actually work directly against other policies and strategies decided upon by departments and agencies outside the scientific policy network.

2. Thus, whilst the North West Development Agency had predicated their Regional Innovation Strategy in part upon the continued survival and indeed growth of the Daresbury public laboratory, no account of this was taken in the decision to locate the new Diamond synchrotron at Rutherford Appleton Laboratory in Oxfordshire. Indeed, it was deemed necessary to provide some £25 million funding to the North West Science Review Team to ameliorate the effects of the decision, thereby illustrating the great public cost of a failure to join up science governance into broader government interests.

3. In a letter dated 28 November, it was announced that the Science and Technology Committee was broadening the remit of their Inquiry to encompass the recent Science White Paper and the medium term Science Budget[1] set out in the 2000 Spending Review (SR2000). The White Paper certainly claims to address the issues of the regional economic problems directly resultant from long-term imbalances in scientific expenditure in the UK. Indeed, in his introduction, the Secretary of State for Trade and Industry states "we need scientific excellence and business innovation in every region, not just a few areas." The Science Budget explained from where the resources would come to meet the commitments laid out in the White Paper.

4. However, it is our contention that neither the White Paper nor the Science Budget offer a commitment to changing the system of scientific governance which has systematically concentrated resources, expenditure and benefits in a few regions of the country in the pursuit of scientific excellence for the nation as a whole. In this memorandum, we offer an analysis of the two documents which seeks to highlight the foregone opportunities as well as the fundamental mismatch between the claims made and the policies offered for using science to promote regional economic development. In our analysis, the problem arises from a conflation of two separate aims of science expenditure, and we argue that a rather naïve conception of the innovation

process leads to the omission of the regional dimension to science and technology (S&T) expenditure in pursuit of national competitiveness.

General Commentary on the White Paper and Science Budget

5. Although the aim of this memorandum is to widen the purview of the regional analysis offered in the initial response to cover the latest policy developments, we believe that the White Paper has a number of weaknesses from whence originates the failure to adequately engage with the regional S&T dimension. The model of innovation used is extremely simplistic, a linear flow from basis research to commercially viable innovative products[2]. However, innovations may actually reduce the "technology" involved in a product or a system—the clockwork radio or solar power eliminates the need for power generation and transmission systems in remote areas. There is thus no simple linear relationship between scientific advances and commercial innovation, and although in sectors such as the pharmaceuticals industry, competitive advantage derives from technological advance, there are many industries (especially capital goods) in which advantage derives from continuity of product and maintenance rather than technological advance.

6. There is also the highly problematic assumption that it is possible in some way to separate out commercial innovation from basic research, and that this is something in which the private sector has great expertise. We would argue that the private sector has already acknowledged that separation of conception and execution in R&D is extremely difficult to manage, and that a firm's innovation base is dependent on more than just those activities which directly in new products being marketed. Best practice in R&D in leading companies such as BT and Glaxo Wellcome encourages professional staff to engage in research for reasons additional to the generation of competitive products. Research activity acts as an incentive to attract the most highly skilled staff as well as to signal to stakeholders (including investors, customers and prospective staff) that they are companies which place research and learning at the heart of their ethos. Similarly, there are many micro-businesses in which individuals perform routine consultancy to fund their own research which is motivated more by their desire as hobbyists to learn rather than the rational commercial benefits[3].

7. The lesson which Government should learn is that leading companies have acknowledged that research activity has two main outcomes, to which we alluded in the first memorandum, namely that research activity delivers outputs such as new products, processes and techniques, but also that research activity maintains a research capacity. Pharmaceutical companies have been quite explicit that the multiplicity of technological avenues being pursued means that they cannot expect to master all the latest technologies. They do have a need to determine which have some likelihood of future commercial success, and this requires a cadre of staff who share professional, linguistic and scientific norms with the research staff in new biotechnology firms. Similarly, in Silicon Valley, it has been observed that (prior to the 2000 downturn), venture capitalists were increasingly indistinguishable in their appearance and technological knowledge from those entrepreneurs in whom they invested.

8. This affirms the need for continued peer review in the allocation of research funds, but more importantly, that research activities encourage a culture from which new research activity can spring. Public sector research is not merely the delivery of services to highly-skilled buyers, rather it is about creating a cadre of staff with the knowledge, interest and opportunity to pursue new avenues of interest. Although the White Paper does state that "knowledge moves with people; people—not institutions or programmes—are the real science base", this comment is made as a coda in a section on the need for the free movement of scientists in Europe (para 2.39). Permeating the remainder of the White Paper is the belief that human capital is something purely reactive, that will move to areas of scientific excellence, rather than that human capital actually comprises, produces and sustains that excellence.

9. Before the issue of the regional dimension of human capital, scientific excellence and economic competitiveness is reprised, there is one other general observation which we would offer to the Inquiry, relating to one disparity between the second and fourth chapters of the White Paper. In chapter two, although the White Paper suggests that commercially confidential work and patents should be included in future within the compass of the Research Assessment Exercise, it overlooks the potential to use the RAE to encourage public understanding of science. Similarly, in chapter four, although the White Paper suggests a need for public debate of science, it appears to be suggesting "Gee-Whizz" theme parks to promote science rather than encouraging an altogether more serious scientific debate predicated upon a wider audience reading, digesting analysing a complex set of ethical and moral arguments. Although we would not propose a specific mechanism, we would strongly recommend that the Inquiry recommend that the funding councils and the DTI urgently consider liaising to best deliver both outcomes.

The Regional Problem, Scientific Capacity and the White Paper

10. The root of the regional problem lies in the top-down approach to the determination of scientific priorities which in turn arises from the heavily centralised system of scientific governance which was established by Realising Our Potential. The last memorandum we submitted responded to this at some length outlining the need for the inclusion of a broader set of interests in the decision-making process through which scientific public spending was allocated. Indeed, the consideration of only national interests was perversely working against the achievement of scientific excellence, by concentrating research activities in particular

regions of the UK, especially the East of England and South East. Although in its introduction the White Paper makes the claim that science is a vital part of regional development across all the English regions, the top-down approach adopted actually works to reinforce the existing patterns of expenditure with their inherent geographies of inequality.

11. In order to illuminate the problem we draw upon the idea of science expenditure having two elements, the delivery of a service and the creation of capacity to perform similar research in the future[4,5]. However, what is important to note (and this is alluded to in para 2.39) is that people are a critical component of each element, and thus buying a research service is necessarily contributing to the support of the capacity to deliver that investment. Therein lies the weakness of the current system for funding allocation in England—directing funding to areas of current research strength is in effect investing in those institutes and centres to form subsequent centres of excellence.

12. The problem we highlighted in the last memorandum was that the UK Science Budget had been stagnant or declining for a number of decades, and consequently, there was a concentration of funds in a comparatively limited number of locations. The corollary of this was that areas of the country lacking existing R&D were being denied the necessary investment to become future centres of excellence. Although worrying for those regions excluded from this scientific core, it poses more worrying questions for the economic competitiveness of the UK as a whole. If industrial competitiveness is predicated upon research activities and those research activities are being concentrated, then this increases the vulnerability of the UK economy to shifts in sectoral competitiveness. If the UK research base is too concentrated towards a few industrial sectors, then it may be insufficiently adaptive to future technological changes. Although the White Paper accepts the need for diversity, it appears not to accept that the current policy arrangement will not produce the requisite heterogeneity.

13. There are also scale problems which arise from over-concentration of activities in particular areas. Cambridge is an exemplar of where a high-technology and high-value economy has been built on the basis of locally-rooted innovation networks, but a local partnership in Cambridge has realised that there are limits to the sustainable growth possible in that one location. Cambridge University is currently experimenting with ways of geographically diffusing the success of the "Cambridge Phenomenon" through other universities in the East of England with a Regional Innovation and Technology Forum, but the importance of people to innovation-based economic success means that such diffusion is not simple. There is no reason to believe that resources channelled into the major provincial cities would not be as effective in raising UK competitiveness, but be more sustainable in providing the infrastructure to absorb related growth of knowledge-intensive industries through spin-off activities.

The New Policy and Funding Arrangement Post-2000

14. There appear to be four elements offered by the White Paper and Budget which have the potential to alter the geographical pattern of investment in Science, ensuring a more geographically-balanced distribution of investment whilst ensuring that particular projects are based with those with the expertise to deliver. These are:

— Investment in capital infrastructure, through the Joint Infrastructure Fund and the successor Science Research Investment Fund,

— Reach out funding (HEROBAC) which will be rolled forward into a new Higher Education Innovation Fund,

— New programmes through the existing research councils and the cross-council research programmes (genomics, e-science and basic technology), and

— The Regional Investment Fund (which is not in fact part of the Science Budget) to fund the implementation of regional innovation strategies.

15. This suggests that a significant proportion of the science budget will be available for investment to support existing, and create new, centres of excellence; the total allocated in 2001–02 appears to be £235 million (13 per cent of the total), rising to £438 million by the end of the period (20 per cent). However, there are significant limitations to the methodologies being adopted to spread the investment resources to maximise the national diversity and expertise of the regions' base.

16. The first is that excellence criteria (ie through peer-reviewed bidding) are being adopted for the allocation of a proportion of the investment funds in higher education. Although the SRIF will allocate £675 million on the basis of quality-based formula, a further £325 million will be allocated on the basis of competitive bidding, either of top-rated bids unsuccessful in the JIF, or from a further round of competitive bidding. It must be appreciated that much of this derives from the unwillingness of the Wellcome Trust (who are contributing £150 million to the SRIF) to take regional economic development priorities rather than research excellence into account in allocating resources[6]. It is therefore absolutely vital that the criteria for the £675 million (which are to be consulted upon) meet the DTI's stated priority that it needs to "build on the excellence of the Joint Infrastructure Fund, but will ensure that the benefits are more widely spread" (p.i.).

17. The second weakness is the differential impact of the Reach Out funds—current Reach Out funding is not provided to directly strengthen regional research capacity, but to encourage universities to deliver those

services in which they excel, which varies in turn with the particular institutional mission. Research-based universities tend to use the funds to win new industrial research contracts, which strengthens their own research base, in contrast to more teaching-based universities, whose reach-out work has significant elements of consultancy and graduate employability (winning little quality research investment). Because research-based universities are concentrated in the South East of England, Reach Out is implicitly supporting this uneven pattern of investment in research capacity. If universities are to act as "drivers of growth in the knowledge economy", then some account should be taken of the regional portfolio of services available and the impact this has on the longer-term investment pattern for region's scientific bases.

18. In this sense, the funding provided for the North West Science Review Team is a particularly welcome break with the current funding principles. It has attempted to ameliorate the negative consequence of concentrating research activity in the South East of England, by creating new research capacity in the region where the misfortune occurred. More importantly, it has some resources (£25 million) with which to achieve this (unlike regional innovation strategies for which no new money was provided). The North West ranks sixth of the twelve UK regions for gross investment in R&D per capita, and this suggests a justification for similar measures for each of the more poorly performing regions. If the £50 million proposed for the RIF were to be restricted to the implementation of RISs in those English regions whose GERS level was at or worse than the North West, then this would provide a similar level of resource to the investment provided by the NWSRT (See Annex).

REGIONAL INPUTS TO THE SYSTEM OF SCIENTIFIC GOVERNANCE

19. The White Paper recognises that the system of UK scientific governance has been transformed through the programme of constitutional change in which various responsibilities for science policy have been devolved to territorial bodies. The White Paper states that "this White Paper is a strategy for the UK, insofar as policy and management of some aspects of science and innovation are reserved to the UK Government" (para 1.32). The measures outlined which apply to the regional aspects of scientific policy are however extremely top-down in their approach, which simultaneously treats all the regions as equal and hence by virtue of the gross geographical imbalance in expenditure, unequal. There are three sets of policy measures outlined in the White Paper which have an explicitly regional dimension:

- Clusters policy, through a Ministerial Clusters Policy Steering Group (3.29) and encouraging RDAs cluster strategies (3.30),
- Stimulating business innovation through the fiscal framework (3.13), and
- Whitehall departmental science and innovation strategies, and the Ministerial Science Group (3.31).

20. Just as in the previous memorandum we highlighted the weaknesses of the top-down Foresight approach, the continuation of that approach works directly against the creation of a diverse and complementary scientific base at which the White Paper is aimed. RDAs are developing their own cluster development strategies alongside the DTI exercise, and in order for cluster policy to succeed, it will be necessary for the DTI to eventually fund those strategies which the RDAs formulate for themselves[7]. RDAs have demonstrated a capacity for identifying those local business linkages which comprise a cluster which are not necessarily financial in nature nor correspond to existing definitions of industrial sectors. Where DTI have a contribution to make is ensuring that the RDAs' cluster strategies are well-researched and reflect genuine regional strengths rather than a nationally-defined set of sectors.

21. The fiscal framework policies are non-spatial in the sense that they offer encouragement to business wherever they perform their innovative activities in the UK. However, they are spatial in the sense that there is a highly unequal geography pattern of R&D in the UK, and consequently the uptake of these support measures is likely to follow this pattern. Although business R&D is not as unequally distributed as government R&D, the fiscal measures outlined represent an implicit subsidy from general taxation, and without measures to stimulate demand in peripheral areas, these represent a highly regressive form of investment in R&D.

22. Finally, to reprise the main theme of our initial response, as the system of scientific governance has been altered by devolution, there is a new geography to the Ministerial Science Group. Whereas actions were hitherto taken in the best interests of the UK, there is now a degree of scientific decision-making formalised between England and the territorial ministries. By consolidating English interests into a single bloc, it has created pressures for the further concentration of expenditure around excellence within England. The English regions lack their own strong voices, and have to be represented by their institutions on the basis of English-wide excellence. Thus, those regions lacking powerful scientific institutions, which are principally located in London, the South East and East of England, are weakly represented in decision-making[8].

CONCLUDING REMARKS

23. There are clear commercial and economic pressures to diffuse the highly productive and internationally renowned science and innovation networks in exemplar UK regions across the rest of the country. Traditional manufacturing activities remain an important contributor to the national output, and firms in those regions can gain all the competitive benefits from innovation and skill development offered by knowledge networks

which high-technology firms in core regions enjoy. There are diminishing returns to scale in a number of core locations, with wage and house price inflation, congestion and environmental degradation beginning to visibly demonstrate the limits to localised high-knowledge growth. Finally, overspecialisation in high-technology research is effectively mortgaging future national economic success upon the continued success of particular industries which may well now be entering maturity with consequently lower levels of profitability.

24. In this memorandum we have outlined that, despite the presence of notional commitment to spatial diffusion of scientific activities, and the inclusion of a limited number of specifically regional programmes such as the Cluster programmes and the associated regional investment funds, the fundamental problem perpetuated (although not created) by Realising Our Potential remains unaltered. The vast majority of publicly-funded research remains allocated according to patterns of expertise which, whilst geographically inequitable, reflect principally historical (and irrational[9]) funding allocations overlain with an asymmetrical political geography of devolution. Indeed, this allocation begets a perpetuation of this existing pattern, and although new centres of expertise have arisen, they must be seen as comparatively piecemeal in comparison with the sustained volumes of expenditure in the South East and East of England.

25. The single recommendation which we could offer to the Inquiry is the need to encourage government to adopt a long-term view of the process of investment in regional scientific capacity. The single greatest investment in research capacity comes through scientists performing high-quality research; under current arrangements, excellence begets excellence but physical concentration weakens the economic benefits through physical congestion and technological overspecialisation. The greater the diversity of the national scientific base, the more opportunity entrepreneurs across the UK will have to take advantage of emerging technological niches to the benefit of the competitiveness of the widest industrial spectrum. Government expenditure must be recognised as a key factor in the continuing science under-performance of the periphery.

26. We believe therefore that there is a compelling case to make fundamental changes to science policy and decision-making to reverse the funding allocations which underpin this unequal and wasteful over-centralisation of research in two English regions to the wider detriment of the UK's economic competitiveness.

Annex

The table below shows the GERD per capita index for the UK regions (excluding figures for research carried out in the private, not-for-profit sector which is excluded from the published information). It can be seen that there are three English regions whose performance is worse than that of the North West, the recipient of £25 million funding in response to the Synchrotron announcement. The North West has a population of some 7 million, so if the £50 million of the RIF were concentrated on the delivery of the RISs in the three worse-performing English regions, this would give £50 million over 13 million population, a similar investment level to NWSRT (separate arrangements from the RIF apply in each of the territorials so they are excluded from the calculations).

Table 1

THE UK REGIONS RANKED BY GERD PER CAPITA INDEX (UK = 100), 1997

	GERD (£m)	*Population (000s)*	*GERD index*
United Kingdom	**14,462**	**58,605**	**100**
Eastern	2,767	5,257	213
South East (GOR)	3,415	7,847	176
South West	1,146	4,828	96
London	1,593	7,007	92
East Midlands	899	4,123	88
North West	**1,503**	**6,899**	**88**
West Midlands	*988*	*5,306*	*75*
Scotland	876	5,136	69
North East	*344*	*2,605*	*52*
Yorkshire & the Humber	*540*	*5,029*	*44*
Wales	257	2,916	36
Northern Ireland	145	1,649	36

Source: economic trends, regional trends, *author's own calculations*

NOTES:

[1] Department of Trade and Industry (2000) *The Science White Paper*, London: DTI; Department of Trade and Industry & Office of Science and Technology (2000) *Science Budget 2001–02 to 2003–04*, London: HMSO.

[2] *cf* "The innovation process is a cycle (which) must be fed by ideas and basic knowledge . . . major innovations flow from breakthroughs made by curiosity-driven research" (paragraphs 1.7-1.9).

[3] *cf* Charles, D R & Benneworth, P S "Creating new products and processes" *Competitiveness Project Thematic Report*, Newcastle-upon-Tyne: CURDS; Benneworth, P S (2001) "Innovation in a peripheral industrial region" *Unpublished PhD thesis*, Newcastle-upon-Tyne: University of Newcastle-upon-Tyne.

[4] This is recognised in the so-called Dual Systems adopted in UK universities in which all establishments receive funds dependent on the numbers of their staff; these funds support teaching and teaching staff are expected to be research active, although these funds are supplemented by the second "leg" of funding, competitive and project-specific research funds, such as those administered by the research councils.

[5] Research capacity is important because of the progressive and indeterminate nature of scientific progress. Many of the benefits that arise from innovation are tangential to the actual research activities, but research activity conditions individuals and teams with new techniques for solving problems; although conceived in laboratory conditions, their application by scientists and engineers to commercial and industrial problems is a vital source of innovation.

[6] This reluctance to support regional development priorities was to prove a decisive factor in the location of the new Diamond synchrotron at Rutherford Appleton Laboratory, Didcot.

[7] *cf* Boekholt, P & Thuriaux, B (1999) "Public policies to facilitate clusters: background, rationale and policy practices in international perspective" in OECD (*eds*) *Boosting innovation: the cluster approach*, Paris: OECD; Charles, D R & Benneworth, P S (2000) Clustering and economic complexity—regional clusters of the ICT sector in the UK' paper presented to *Do clusters matter in innovation policy*? OECD Cluster Group Workshop, Utrecht, Netherlands, 8-9 May 2000.

[8] This is exemplified by the science enterprise challenge centres, where the initial competition resulted in centres for all regions with the exception of Northern Ireland and the North East, which was overturned when these centres were provided through funds released by the creation of the Cambridge-Massachusetts Institute. This demonstrated once more the commitment of the DTI to funding existing excellence over diffusing diversity across the UK regions. The DTI provided funds to one centre (at Cambridge University) at a level well beyond the total funds provided to the remainder of the UK network.

[9] *cf* Heim, C E (1988) "Government Research Establishments, state capacity and distribution of industrial policy in Britain" *Regional Studies* 22 (5) pp 375–386.

APPENDIX 57

Memorandum submitted by British Telecommunications plc

In general we are in full agreement with the major proposals emerging from the White Paper and in particular welcome the strengthening of links between universities and business and the design blueprints for investment and support to encourage companies to innovate and adopt new technologies. However, we would like to ensure that excellence in R&D is retained and the emphasis on skill building is maintained and is not lost in the drive for a more entrepreneurial culture. Both need to exist side by side.

We welcome the Government's promises to invest in renewing the infrastructure for science and technology at higher education institutes which is sorely needed. The additional money that will go towards key technology areas that will shape life in the 21st Century such as genomics, nanotechnology and quantum computing is essential if the UK is to improve its position in wealth creation and the quality of life of its people.

The additional money to support post-graduate research students is also welcome as is the innovation of an extra £4 million to assist in the recruitment and retention of fifty top researchers in the UK. However, we see this as a stop-gap measure, in that we believe that if the UK is to retain top academics, wherever they are in this system, then the overall level of remuneration in higher education needs to be improved. We believe this would also go some way to raising the status of scientists and engineers and make this a vocation that many young people would want to follow.

As we stated in our previous submission to this Committee, we believe that capturing children's imagination and encouraging them to take up careers in science and engineering must a priority in any policy and technology. We therefore welcome the Science Ambassador's Programme but again believe this should be an ongoing programme which should continuously impact children in both primary and secondary education.

In terms of Foresight, we are pleased to see that a Foresight fund will be put in place but would very much welcome detailed strategic documents outlining the Government's science and technology programme for each department. These we would envisage as a central plank of government policy. We believe these could be core documents which would allow government, industry and academia to plan for the future. In addition, we believe that a Minister of Cabinet rank with responsibility for science and technology would also send the right messages concerning the Government's priorities in Science and Technology.

We stressed in our last submission that the programme for Higher Education Reach Out to Business and the Community, HEROBAC, was welcome and really encouraged universities to work with local businesses. It is pleasing to see that this will receive extra money over the next three years. The additional money allocated to new regional innovation funds is something we at BT are particularly interested in, given the emphasis that we have placed on establishing the Cambridge/Ipswich high tech corridor. We are, via our own Brightstar initiative, encouraging clusters and incubators to be set up in the local environment and also at our central R&D site at Adastral Park. The new corporate venturing tax reliefs established by the Finance Act 2000 are unfortunately of no help to BT here—because the rules are so narrowly drawn (not to say unduly complex), none of BT's investments in start up companies set up so far would qualify. This would indicate either a positive policy decision to exclude such companies from the relief or that the relief is itself misdirected.

We are also encouraging the links between academia and business by our involvement in the Massachusetts Institute of Technology and Cambridge Initiative, CMI, and we have also partnered with University College London to set up on site at Adastral Park. As part of this initiative we are encouraging other industries in the area to be partners in this exciting university venture. In the future, we intend to establish a corresponding business school alongside this technology development. We would be happy to share our experiences in this arena with the Select Committee.

Two areas which we feel are not fully addressed in the White Paper are the efforts needed to address the skill shortage, particularly in the area of IT and communications. We are not sure how the Government is going to deal with this as it earns only passing comment in the White Paper. We understand that the imposition of new rules by the Inland Revenue under IR35 has made the UK a less attractive location for IT professionals operating through their own company and this must surely run counter to the Government's stated intention of putting the UK at the forefront of the IT revolution.

In addition, we have some concern over the proposal to change the rules regarding ownership of intellectual property rights, especially within academia. This needs to be carefully considered so as not to drive away industry from investing in academic research. There is real possibility of this happening. A number of years ago industrial development officers in academic institutes tried to claim all the intellectual property rights generated under industrial contracts as belonging to that academic institute. This caused major problems for larger industrial concerns and led to many contracts with academia being cancelled. This was very difficult for pharmaceutical companies in particular who survive solely on their intellectual property, so whilst endorsing entrepreneurialism within universities, we feel the issue of governance over intellectual property rights needs to be thoroughly thought out. We would be happy to take part in any discussions on this topic as we have significant experience in this area. Please contact Dr Graham Davies.

We would also be happy to provide guidance on the posting of intellectual property rights on internet sites which is not such a simple matter as described in the White Paper. What is posted and how it is written is critical if one is to achieve any significant sales. We would be willing to share our experience with companies such as Yet2.com and uventures who already operate in this space.

Finally, we reiterate our concern over the scientific debate that goes on in the media. We believe it is essential to have transparency on all topics relating to science and technology if the public at large is to be a partner in this process. However, we would like to see a well reasoned debate taking place on peer reviewed material. Where such debate is conducted in an environment of limited understanding, there is the danger that "the baby will be thrown out with the bath water" and that the potential benefits to the quality of life and to the UK economy as a whole will not be fully realised.

We would suggest if an increase in R&D is to be achieved it would be worthwhile considering enhanced tax beliefs for large, as well as small companies, as it is within large companies that the vast bulk of R&D is conducted. It is unlikely to cost the Exchequer inordinate amounts in tax relief but may well have a disproportionately beneficial effect on the R&D environment in the UK.

In conclusion, we believe that this White Paper and its proposals are a significant step forward in raising the profile of science and technology, not forgetting engineering, as a cornerstone in the Government's overall programme.

10 January 2001

APPENDIX 58

Memorandum submitted by the Society for General Microbiology

SGM is a learned society and a registered charity with over 5,000 members worldwide. The Society provides a common meeting ground for scientists working in fields with applications in microbiology including medicine, veterinary medicine, pharmaceuticals, agriculture, food, and the environment. SGM is committed to representing the science and profession of microbiology to government, the media and the general public; supporting microbiology education at all levels; and encouraging the uptake of careers in microbiology.

PhD Stipend Increase

The Follet committee has done an excellent job in persuading OST of the need to raise the stipend of PhD studentships, and this increase is long overdue. Of course it would be even better to see the increases appear earlier.

The UK Life Services Committee (of which the SGM is a member) has called for the number of Life Science PhD places to be reduced. There is now serious discussion at MRC level about four-year studentships linked to MRes courses, and this has also been debated at BBSRC. If this happens then inevitably the number of studentships available will fall and there is a danger that these will be focussed in the major research centres only! It must be determined whether it is solely the low stipend that is failing to attract PhD students. Lower numbers of available studentships may result in perceptions among students that research career opportunities will be confined to the elite.

Research Infrastructure

The further £1 billion funding for infrastructure is very welcome but still falls short of fully restructuring British Science. SGM Council noted that a lot of money was wasted by Universities in getting JIF bids together that were ultimately unsuccessful, eg surveying, planning permission etc. This also takes up a lot of academic and administrative staff time. A pre-screening step, so that only proposals that get through the first stage are invited for the full proposal, could save universities money.

Cross-Council Research Programmes

The budget identified three key areas of research: genomics, e-science and basic technology. Microbiology is a key subject in all three, to varying degrees, and the SGM welcomes government investment in them. Cross council initiatives and co-ordinated programmes encourage idea generation.

The Society was surprised that more emphasis was not given to environmental science, in particular the impact of environmental microbiology. We recognise that this falls mainly within the NERC's remit. However, subjects such bioremediation should be considered as part of a cross-council programme, and will require collaboration between microbiologists, engineers, ecologists, chemists etc.

Separate biological science departments, such as microbiology departments, are becoming a thing of the past, and most viable research groups are now in centres, institutes or laboratories. Although this does not compromise applications for funding, indeed grants are more likely to be awarded to multidisciplinary "centres of excellence"; problems may arise in the Research Assessment Exercise due to blurring of university department boundaries. For example the breadth of microbiological research may mean that it is evaluated in the biological sciences, agriculture or medical units of assessment. There is a belief that this could lead to differing RAE scores depending on the unit of assessment involved, and a need to ensure that interdisciplinary work is assessed.

Communicating with the Public

The Office of Science and Technology initiatives to communicate with the public must involve learned societies to a greater extent. Societies such as the SGM have many resources available to inform the public. The SGM runs workshops and produces information packs for teachers; produces posters and leaflets for schools; and organises lectures and demonstrations. SGM encourages young people to take up a career in microbiology by distributing literature to schools and colleges, attending careers events and promoting the subject in the media.

General Comments

The research council budgets give no idea of the funding split between universities and institutes.

It is unclear how increases in the science budget will reflect on individual Government department R&D budgets. For example, in the last spending review MAFF's budget actually fell. It is important that departmental R&D spending is maintained.

10 January 2001

APPENDIX 59

Supplementary memorandum submitted by the Environment Agency

1. INTRODUCTION

The Environment Agency submitted evidence in June 2000 to the Science & Technology Committee's inquiry into "Are We Realising Our Potential?" This additional memorandum is submitted in response to the further invitation to submit evidence, commenting on the new Science & Innovation White Paper on the Science Budget.

Comments on six issues are set out below. The first three relate to areas of concern addressed in the Agency's earlier evidence. Comments are made on the extent to which the White Paper meets those concerns. The latter three are additional issues arising from the White Paper.

2. BRIDGING THE GAP BETWEEN SCIENCE AND ITS APPLICATION

Our earlier evidence indicated that there are a number of constraints to achieving effective team-working between organisations in the science, engineering and technology (SET) base and public sector organisations like the Agency that use the research. The White Paper appropriately recognises the need to strengthen the links in the chain of innovation in the UK and the need to embrace each stage of the innovation cycle. It is essential that users, researchers and others involved in the R&D chain work together to address the weakest links.

The difficulties experienced in financing the development and demonstration stages of the innovation cycle, as discussed in our earlier evidence, are recognised in the White Paper. The funding initiatives described in chapter 3, for example the higher education innovation fund, the extension to the university challenge competition and Faraday partnerships should provide a welcome boost to key development activities. It will be important to monitor the effectiveness of these initiatives, taking particular account of feedback from industry and public sector organisations.

The White Paper points to the need for a diversity of excellence in universities, including both research excellence and knowledge transfer (chapter 3, paragraph 6). Our previous evidence expressed some concern that a focus solely on scientific excellence, particularly as measured by the number of scientific publications, as the basis for funding of academic institutions could be counter-productive in respect of promoting close relationships with industry and end-users. It is therefore encouraging that guidance for the next Research Assessment Exercise indicates that equal weight should be given to basic and strategic research done in confidence for business, alongside papers published in peer reviewed journals.

7. INTELLECTUAL PROPERTY

The White Paper appropriately emphasises the need to encourage universities and public sector research establishments to develop mechanism for the effective exploitation of their intellectual property. The Agency has commented separately on the Government consultation on its response to the Baker Report on these issues. A particular concern is the proposed presumption in favour of the ownership of intellectual property residing with the contractor in respect of research sponsored by non-departmental public bodies. The Agency considers that this assignment of rights could be counter-productive.

11 January 2001

APPENDIX 60

Memorandum submitted by the UK Life Sciences Committee

The UK Life Sciences Committee comprises 16 leading learned societies and represents some 35,000 cell, molecular and physiological life scientists working in academia and in industry. The UKLSC is pleased to provide additional evidence to the Science and Technology Committee inquiry.

1. UKLSC was pleased overall with the White Paper, which showed clear evidence that the Government had listened to the views of people and organisations working to sustain and improve the excellence of Britain's science. For example, in a special pre-White Paper edition of Science and Public Affairs a member of the Commons Science and Technology Committee, and senior people in science policy at SmithKline Beecham, the Wellcome Trust, and the Royal Society listed as their priority issues:

- the need to maintain a strong science base;
- the need to strengthen links of the science base with wealth creation, including the need to simplify the technology transfer initiatives;

- the need for an improved academic career structure to aid recruitment and retention of the best young scientists;
- the need for diversity of mission among universities;
- and the need to improve the public perception of new scientific developments.

These were all identified in the White Paper, but not always addressed adequately.

2. The most notable deficiency of a Paper that claimed to be a strategy document for science and innovation was the failure to address the issue of pay and conditions for the overwhelming majority of academic scientists. The move to improve PhD stipends recognised the growing problem of attracting the best students to start out in research, although it has to be recognised that the increase was from a very low and uncompetitive baseline. The pool of funding intended to reverse the brain drain and attract a limited number of top researchers to the UK was useful. Such innovators can be an impact disproportionate to their number. But the White Paper did not address the fundamental problem that some of the brightest young scientists choose not to pursue careers in academic research because of the lack of prospects.

3. The continued funding after the JIF to improve infrastructure was welcome. It will need to be monitored, so that the requirement for universities to obtain sponsors for 25 per cent of the costs of any projects funded does not result in undue bias towards a small number of research-intensive institutions.

4. Following the Comprehensive Spending Review of 1998 the Government was criticised for balancing increased investment in the Science Base with decreased on R&D by government departments. It is still not clear whether the money announced for the Science Base represents new funding or largely a reshuffling of existing money. The fact that the OST still has little influence on the setting of R&D budgets by other government departments militates against a joined-up Government science policy.

5. The White Paper's acknowledgement of the responsibility of the government for funding basic research and maintaining an excellent science base, whilst at the same time clearly wanting to exploit any discoveries made, is welcome. UKLSC agrees the need for selectivity of funding for basic research, and for universities to have a diversity of missions. The increased size of the HEROBC pool as a permanent third leg of funding should encourage more universities to expand their work with business and the community.

6. The initiatives for technology transfer were largely extensions of existing schemes and whilst welcome, do not appear to have simplified procedures. Funds to strengthen regional science and to create networks, to be made available through regional development agencies, will be welcomed although UKLSC pointed out in an earlier consultation that much collaboration is carried out on a national or international scale rather than at a regional level.

7. The section on public confidence contained many fine words but few definite actions. The emphasis on the updated guidelines on the use of scientific advice by government departments and agencies, and a new code of practice encouraging openness for advisory committees, may be of limited value. Similar guidelines and advisory committees were in place in the last two years when the public mistrust over genetically modified foods grew. Little was said about encouraging scientists to engage more effectively with the public other than that the Government would build on existing research council initiatives in training scientists to communicate their work. Furthermore, focus needs to be placed on mechanisms to enable the public to have more input into science decision-making.

11 January 2001

APPENDIX 61

Supplementary memorandum submitted by the Biotechnology and Biological Sciences Research Council

INTRODUCTION

1. Having submitted a memorandum to the Committee's inquiry into the impact of the 1993 White Paper, *Realising our Potential*, the BBSRC welcomes this opportunity to contribute further evidence related to the publication of the 2000 White Paper, *Excellence and Opportunity: a science and innovation policy for the 21 century*, and of the *Science Budget 2001–02 to 2003–04*. Both initiatives have obvious significance for the future of the research base in the UK and, in particular for how research results might best be exploited to the benefit of the UK economy and the well being of the population.

2. This submission will comment briefly on each of the two documents, and then consider how the proposals set out might meet the concerns outlined in the final paragraph of the BBSRC's earlier submission.

THE SCIENCE AND INNOVATION WHITE PAPER

3. The BBSRC welcomed the publication of the White Paper, especially its recognition of the close relationship between research excellence and capacity for effective innovation (chapter 1, paragraphs 7 to 18). The emphasis on the cycle or chain of innovation and the need to maintain all aspects of it, from the excellence of basic research to public confidence in scientific ideas and consumer demand, provides a useful framework for the development of policy at the departmental/research council level. However, it remains to be seen how effectively the proposals set out in chapter 1 may be implemented across government.

4. The document as a whole is strong on identifying the UK's need to maintain its international standing by, for example, keeping and attracting the best brains, and improving the quality of school teaching. It also sets out a number of very positive key proposals (paragraphs 32, 35 and 37), several of which commit the Government to significant investment in the research base. These are very welcome developments, as is the White Paper's recognition of the need to continue to address the following:

- how best to encourage productive international links (ch 1, para 34);
- the need for adequate rewards at all stages of a research career, but particularly for younger scientists (ch 2, paras 31–34). The response of the main employers of scientific staff to the Research Careers Initiative agreed by the CVCP, OST and the research councils in 1996 has been positive, but much more needs to be done to develop systematic career guidance and skills training structures for postdoctoral staff, together with more attractive recognition and reward schemes. The White Paper was disappointingly muted on these very important practical issues.
- why so few women are in senior posts (ch 2, paras 35–38);
- the need to maintain public confidence in scientific research (ch 4).

5. Chapter 3, "Opportunities for innovation", provides a clear analysis of the relationship between the research base and innovative economic activity, and emphasises the need to strengthen what it calls the "links in [the UK's] innovation cycle" (ch 3, para). It also sets out a variety of schemes aimed at meeting that need. The extent to which these schemes will deliver stronger links remains open to question. While broadly welcoming the initiatives, the BBSRC would wish to have some flexibility to adapt the schemes to the particular circumstances of the UK biosciences research base. The Council would also wish the Government to give a clearer indication of an appreciation of the role of the research councils' research institutes in generating knowledge and translating it into biosciences products.

THE SCIENCE BUDGET 2001–02 TO 2003–04

6. The BBSRC particularly welcomes the encouraging settlement for research resulting from the Spending Review 2000, which built on the ideas set out in the "Science and Innovation" White Paper, and provided further details of how the Government's investment in science is expected to deliver the required results. The headline commitments, £1 billion for infrastructure, £252 million for key areas, £100 million boost to the science budget over three years, a rise in the postgraduate student stipends to £9K pa, and £10 million to help the commercialisation of public sector research, will all be extremely important in allowing the research councils to maintain the international strength of the UK Science Base.

7. Within the BBSRC's areas of the interest, the investment of £110 million in genomics, 30 per cent of which has been allocated to the Council, will enable the BBSRC to make significant investments in leading UK research groups: plans are now underway for a major initiative in "Exploiting the genome". This will build on the Council's previous investments (for example the initiative "Investigating gene function", and its structural biology centres) by analysing and interpreting the vast amount of genome data generated to the benefit of the UK economy.

8. The BBSRC also appreciates the commitments to e-science and basic technologies. For the former, the Council is now in a position to continue its commitment to bioinformatics, and to fund other e-science applications in post-genomics. Part of the Council's programme in this area will be jointly with the Medical Research Council, thereby contributing to effective joint working between the research councils as emphasised in the science budget settlement. Effective joint working between the councils will be vital throughout the three key areas of new funding, and strategic vision for the development of the UK Science Base as a whole will be essential in the next period of scientific advance.

BBSRC CONCERNS

9. In the BBSRC's first submission to the inquiry we outlined a number of specific concerns about the ability of the UK science base to drive forward the knowledge based economy and society. This section considers the extent to which the proposals in the White Paper and the SR2000 settlement meet those concerns.

Providing resources to ensure the UK remains internationally competitive in scientific research

10. While it is always possible to seek additional funds for research, the BBSRC recognises that the settlement from SR2000 goes a long way towards ensuring the continued international success of the UK Science Base. It will be essential for the research councils to allocate the resources effectively, balancing concentration on centres of excellence with the need to maintain and encourage diversity of sound scientific ideas.

Keeping the physical infrastructure for the Science Base up to the highest international standards in key research centres in universities and research institutes

11. The Joint Infrastructure Fund announced after the 1998 Comprehensive Spending Review started the long-term and much needed process of replacing and updating buildings and facilities at universities and research institutes. It was important that funding be made available to continue this activity. The SR2000 settlement for infrastructure (the Science Research Investment Fund) was therefore vital. In prioritising the ways in which the SRIF is allocated lessons need to be learned from the procedures for awarding funds under JIF, to ensure that funds are distributed equitably and effectively. In particular, future decisions about the allocation of such significant sums of money must be taken in the context of a strategic view of scientific infrastructure needs across the Science Base as a whole. The importance of ensuring an effective national overview of the development of the infrastructure for the Science Base is growing, so that we can be sure that best value is secured, and the unhelpful duplication and sub-critical mass are avoided. In particular, working between institutions should be strongly promoted.

Ensuring that government-supported knowledge transfer schemes are effective and that resources are available for early stage development of ideas generated from the research base

12. The main thrust of the White Paper is clearly on this aspect of the Government's responsibilities, and the SR2000 settlement provides a number of specific schemes for bridging the gap between research results and commercial/industrial success. While very much welcoming these developments, the BBSRC believes there may still be a gap between obtaining initial results, securing intellectual property, and testing the results sufficiently to interest private sector investors.

Ensuring that the teaching of science subjects in schools is not undermined by poor facilities or poor quality teaching, and the issue of salaries for secondary school teachers

13. The White Paper clearly recognises both the growing difficulties faced by schools in recruiting good science teachers and the need to improve further the links between the research base and schools. These matters, particularly the former, are of increasing concern to the BBSRC, as evidence of the absence of adequately qualified science teachers in secondary schools mounts. Relatively few postgraduates are now opting for a career in teaching, and BBSRC would welcome a national debate about how this situation could be tackled. The Council has an excellent record of promoting links between the bioscience research base and schools but is less well placed to address directly the issue of the quality of school science teaching. The Government's plans to offer £10,000 as training and recruitment packages for teachers in shortage areas may help ease the situation, but a longer-term approach addressing the questions of salaries, teacher status and school infrastructure may also be required. Closer interaction between the Department of Trade and Industry and the Department for Education and Employment in developing policy specifically on science in schools might also be helpful.

Raising PhD stipends to a level that will attract high flyers

14. The low level of PhD stipends has long been of concern to the BBSRC. The Council was therefore particularly pleased with the commitments in the White Paper and the SR2000 settlement to raise stipends. However, there is still some concern that £9Kpa by 2003–04 may not be sufficient, and the BBSRC is considering moving more quickly to that level and may wish to enhance stipends further. The attractiveness of these increases will be partly influenced by the wider attractiveness and status of research careers beyond the PhD stage, and the role of the Government in that respect must not be overlooked.

Making research careers more attractive by reducing the incidence of short-term contract employment in the early stages of a career, and increasing the level of early career remuneration

15. The BBSRC recognises that these issues were raised in the White Paper. The initiatives underway will have some impact, bit it seems likely that this area will require further action if scientific research is to compete with the other careers open to PhD graduates.

Ensuring that public debate about science is well informed, and that increased weight is placed on assessing the views of the public before establishing research priorities

16. The Council particularly welcome the initiatives in this area, including the proposed Code of Practice for all scientific advisory committees, the emphasis on improved scientific communication, and the recognition of the role played by consumers in the innovation cycle. The BBSRC has now geared specific website pages to gather views from the wider public on each new research initiative which the Council proposes to launch. It also offers via its website comprehensive information about contemporary bioscience research and the social policy and ethical issues which are implied. It would welcome increased use of these pages by schools as a means of encouraging scientific literacy and informed debate about the issues raised by the modern biosciences.

January 2001

APPENDIX 62

Memorandum submitted by the Association of University Teachers

As you can see, we have deliberately focused our submission on one aspect of your enquiry, namely the section of the 1993 White Paper entitled "research careers in universities".

The experiences and concerns of the 36,000 fixed-term contract research staff (CRS) as the main practitioners of science in UK higher education are of crucial importance to the delivery of science policy in this country. As such, we feel it is important that the Committee takes account of the issues attached in our evidence during its deliberations.

INTRODUCTION

The Association of University Teachers (AUT) represents over 40,000 academic and academic-related staff in UK universities, colleges and research institutes. The future of UK science and technology is a key concern for the association. We have been an active member of the Science Alliance, an informal grouping of the main science unions, which has sought to promote discussion on science and technology issues.[1]The association, therefore, welcomes the opportunity to respond to the Science and Technology committee's inquiry into the impact of the 1993 white paper, *Realising our Potential.* We also welcome the decision by the committee to extend this inquiry to take into account the 2000 science and innovation white paper, *Excellence and Opportunity* and the recently announced science budget.

In this submission we want to focus on one aspect of the 1993 white paper, the section entitled "research careers in universities". As a trade union and a professional association, we are especially concerned about the plight of the 36,000 fixed-term contract research staff (CRS) currently employed in UK higher education.[2]The association believes that casualisation undermines career progression, creates great insecurity, erodes academic freedom, and contributes to the levels of stress experienced by academic and related staff.[3]In addition, the growth in the numbers of CRS continues to be a major barrier to the recruitment and retention of high quality staff, as the 1993 Science White Paper itself recognised.[4]

Research careers in universities: "Are we realising our potential"?

The 1993 White Paper was instrumental in focusing attention on the training and career development of researchers. It prompted the signing of the *Concordat on Contract Research Staff Career Management* and the establishment of the Research Careers Initiative (RCI), both designed to improve the careers of contract research staff. These initiatives, however, have done little to challenge the prevailing "contract culture". University employers and the funding and research councils have failed to reduce the scale of CRS. In fact, recent research produced by the association found that the level of casualisation of research staff in the UK has marginally *increased* since 1995–96, despite the initiatives emerging out of the White Paper. A staggering 94 per cent of "research only" staff in 1998–99 were on fixed-term contracts.[5]

Unfortunately, the problems of CRS have not been a major theme in the recent oral evidence presented to the Science and Technology Committee.[6]Moreover, the new Science White Paper, *Excellence and Opportunity*, devotes just a single paragraph to considering issues related to CRS. Paragraph 34 states:

"Young people need to be able to see that jobs in university research lead somewhere – whether within academia or to careers outside. We are concerned about career development prospects for young people starting out".[7]

This reveals two misconceptions about CRS:

- CRS are young people "starting out"

- Research posts in HEIs funded by external research projects, are transitory, the only long-term jobs being "academic (lecturing)" posts in HEIs, or jobs in industry.

Unfortunately, similar assumptions are made in the recent Fundamental Review of Research conducted by the Higher Education Funding Council for England (HEFCE).[8]This document makes the assumption that CRS are young, inexperienced and temporary "post-doctoral assistants" who are yet to begin proper academic careers.

These misconceptions and assumptions should be corrected and challenged. Far from being temporary and short-term, a significant proportion of CRS have served in institutions for a long period and are highly experienced researchers. For example, an OST analysis in 1997, showed that, of those ex-research council PhD students who had entered higher education as CRS, nine years later 33 per cent were still in academia as CRS.[9]Similarly, figures from a recent survey of researchers at Bristol University found that 45 per cent were employed as CRS for 3-10 years and 12 per cent for more than 10 years.[10]The most recent HESA data (1998–99) also reinforces this point about the experience of CRS. 45 per cent of all 35-39 year old academics were on fixed-term contracts, and 93 per cent of "research-only" staff aged 35-39 were also on a fixed-term contract (representing 15 per cent of the CRS total).[11]

We therefore, recommend a more realistic model of how university research is delivered. The basic principle is that there is essentially a single group of staff—academics—undertaking a spectrum of research (R), teaching (T) and administration (A) within HEIs today. HEFCE-funded lecturing staff may tend to have a balance between R, T, A. CRS will do a much higher proportion of R, but are still likely to undertake some T and A, including training of PhD students. There will be fine-grained interactions between all research staff, especially when working in research teams. PhD students will also make significant contributions to research and teaching output. The range of research activities—blues skies, grant applications, management, crux research—may be undertaken by members from either of the staff groups (PhD students may also be involved in these). Both staff groups will have a range of experience in various aspects of research, including contributing to the RAE and other prestige ratings. Above all, there will be CRS who have achieved many years of service within HEIs, in the face of significant obstacles due to the casual nature of their employment. This valuable contribution to university life needs to be openly acknowledged—and properly rewarded—by the relevant stakeholders.

Prospects for improving employment practices

Paragraph 34 of *Excellence and opportunity concludes*: "...and so we are encouraging the university employers and the funding and research councils to develop:

- targets for, and better monitoring of, institutional performance in managing contract staff;
- recognition and reward schemes for the development of researchers;
- promotion of relevant evaluation and best practice models; and
- better provision and co-ordination of career guidance and staff development resources."

We would argue that this does not go nearly far enough. All evidence so far reveals that HEIs will not develop any meaningful changes to CRS "management" or "development". The Concordat has produced virtually no concrete changes since 1996. The second report of the Research Careers Initiative (RCI) makes for extremely disappointing reading. It reveals that progress for better management of CRS has been slow or non-existent, with many HEIs not even implementing the basic RCI recommendations.[12]

The assumption that fixed-term contracts for certain academic researchers (ie those working on externally-funded research projects) are inevitable, is also evident in the *Excellence and Opportunity* White Paper: ("30,000 or more researchers are on fixed-term contracts"). This fatalism is disappointing. Not all the relevant stakeholders believe that the current reliance by HEIs on multiple fixed-term contracts for researchers is inevitable. Certain research councils, for example EPSRC, believe that CRS should move on, either to permanent non-EPSRC funded posts in universities, or out into industry in order to maintain a flow of research experts into the wider economy. In discussions with the AUT's CRS committee, EPSRC have acknowledged that HEIs should be prepared to employ researchers on open-ended contracts.

One possible way of achieving this is to encourage universities to pool income streams. This would be likely to involve sharing the finances for staff costs at the level of the institution rather than the current system which devolves staffing responsibilities to departments, sections, or research groups. The current mindset of university managers leads them to treat fixed-term staff as a variable cost, whereas treating staffing costs as an essential overhead would encourage employers to view employees as a long-term and valuable asset. To achieve this would undoubtedly require a paradigm shift in thinking among employers and research councils in relation to research funding. Nevertheless, this should not be such a daunting task for institutions whose underlying principle is to move beyond the boundaries of conventional wisdom.

Building a science and innovation policy for the 21st century: the role of CRS

In its review of science and innovation policy, the Government should firstly ensure the establishment of an accurate model of how research is conducted in universities, in particular considering the role currently performed by CRS. Secondly, it should instruct the national bodies responsible for academic research (university employers and the funding and research councils) to implement the RCI recommendations. One immediate initiate would be for the Government to ensure that other funding councils extend work undertaken by the Scottish Funding Council to improve conditions for researchers. Thirdly, the Government should question all aspects of the effectiveness of keeping such a large proportion of academic researchers on fixed-term contracts. The association considers that such contracts are wasteful and inefficient, let alone damaging and demotivating for all staff concerned. This review is concerned with effective delivery of excellent science, and so this is an ideal opportunity to address these problems. Rather than assuming casualisation is an "opportunity", this means challenging the presumption that casualised labour is the best and only way to deliver research in the 21st century.

Notes

[1] See, for example, the discussion document Contract or Career: a career in science?, Science Alliance, March 1996.

[2] According to data from the Higher Education Statistics Agency (HESA), there were 36,471 full time fixed-term research-only staff in 1998/99 (out of total of 130,534 academic staff).

[3] On stress, see Association of University Teachers, Pressure points: a survey into the causes and consequences of occupational stress in UK academic and related staff, Spring 1998, London: AUT.

[4] Realising Our Potential: A Strategy for Science, Engineering and Technology, Cm2250, May 1993, para 7.27-7.31.

[5] Association of University Teachers, Trends in casual employment in higher education, http://www.aut.org.uk/pandp/index.html.

[6] The one exception was the submission from the CVCP. Even here they misrepresent the nature of the problem. For example, there is no empirical evidence to assume 70 percent of CRS staff should not expect a career in university research. The memorandum can be found at: http://www.parliament.the-stationery-office.co.uk/pa/cm199900/cmselect/cmsctech/466/0061402.htm.

[7] Excellence and Opportunity: a science and innovation policy for the 21 century, DTI, 2000, p.23.

[8] HEFCE, Fundamental Review of Research Policy and Funding, September 2000. See http://www.hefce.ac.uk/Research/default.htm.

[9] K Sproston and J Field, Survey of Postgraduates Funded by the Research Councils, OST, 1998.

[10] University of Bristol Personnel Department, "Results of CRS Questionnaire—December 1999". See: http//www.bris.ac.uk/Depts/Personnel/CRS/c-crsle.html.

[11] AUT analysis of HESA 1998–99 Individualised Staff Record.

[12] Research Careers Initiative, 2nd Report, May 2000. For the first and second reports, see http://www.universitiesuk.ac.uk/aboutus/partnershipactivities/

January 2001

APPENDIX 63

Memorandum submitted by Science City York

1. SUMMARY

1.1 Science City York is a joint partnership between City of York Council and the University of York, with significant private sector input. Set up in 1998, the project built on the success of Bioscience York which was established in 1995, making it one of the first cluster developments in the country, and provides specialist help to high technology companies in three sectors, bioscience, e-science and heritage and arts technology. Already more than 6,800 people are employed in this dynamic initiative, and the pace of growth is set to create in excess of 1,600 further employment opportunities by 2003.

1.2 For the past two years Science City York has been facilitating the development and promotion of clusters within the York area. As part of this work, specific barriers to the growth of clusters have been identified. We would like to see the following points addressed by government to ensure the rate of cluster development continues.

1.3 *Recommendations*

The consolidation of funding sources, and a longer life-span for awards and grants.

Targeting new resources on functional activities, such as promotion.

A more integrated approach to planning and economic development to speed up the process to match the pace of growth in science based industry.

The special requirements of knowledge based industries to be recognised in the UDP land allocation process.

The continual involvement of higher education institutions as an essential part of cluster development.

That developers are encouraged to offer shorter term property lets.

That the pace of change in opening up the local telecoms market continues to ensure lower bandwidth access costs.

2. SCIENCE CITY YORK—A SUCCESSFUL PARTNERSHIP

2.1 Science City York is geared to meet the needs of high technology companies through a specialised programme of assistance, providing the right supportive environment to allow businesses to grow and flourish. It supports the promotion, development and exploitation of three interconnected clusters in the York area:

- Bioscience York includes over 48 firms, employing over 2,500 life scientists working in bioscience within an eight mile radius of the city, and is recognised as one of the country's most exciting bioscience clusters. This cluster is particularly strong on drug development, plant biotechnology, health and food sciences.
- Facilities include a new strategic research centre at the University of York: the Centre for Novel Agricultural Products, with a mission to undertake inter-disciplinary research in this area.
- e-Science York is a fast-growing information and communication technology cluster with over 130 firms, employing 2,600 people in the City. The University's world-class Departments of Computer Science and Electronics, producing over 200 graduates a year and with a proven record of spin-out companies provides invaluable support.
- Heritage and arts technology links York's traditional economy and heritage with the knowledge based economy. The established infrastructure of attractions has seen the City develop expert visitor management techniques to accommodate four million visitors a year.
- A critical mass of creative interpretative and education expertise has developed, building on York's existing commercial and academic strength, with 55 specialist organisations operating in the field employing over 1,000 people. These include specialist data services, conservation, display design and technology and multi-media content and the creative application of technology.

2.2 In total, Science City York has seen since its establishment 40 technology transfer projects, eight spin-outs and eight inward investment successes. Results from a comprehensive survey (with an 85 per cent response rate) highlight that between July 1998 and July 2000, a growth of over 1,000 jobs or 18 per cent has been generated as a result of Science City York.

2.3 Aside from the University and the City Council, funding partners involved include York Inward Investment Board, York Business Development Ltd, North Yorkshire Training and Enterprise Council and the European Union through European regional development funds from the Konver II programme. The success of the initiative also relies on the input of local schools, colleges and local business across all sectors.

3. THE WHITE PAPER—EXCELLENCE AND OPPORTUNITY

This submission looks at five areas of the White Paper "Excellence and Opportunity" in which we have a particular interest and where we have considerable experience.

3.1 *Funding*

3.11 We welcome the acceptance in the White Paper that clusters form an important element in regional economic development. We also welcome the new money for RDAs and a Regional Infrastructure Fund. However, we are concerned that the short-term nature of much government funding is proving a constraint on growth. This form of funding prevents medium to long-term planning, and the application process absorbs considerable time.

3.12 Investment in cluster development from within the technology community requires the development of sustainable funding mechanisms in order to lever in private sector involvement. The joining up of government resources, both national and regional, into a framework which enables all partners to plan on a longer term basis would be very beneficial to future growth.

3.14 More resources for specific functional activities would lead to greater growth. A recent report by the Regional Biotechnology Cluster Association Forum, which benchmarked UK cluster development against international competition, demonstrated that trade promotion, the attraction of inward investment and the promotion of technology transfer would lead to more activity.

The level of funding support for clusters is crucial in supporting the sector, especially as there is growing international competition, particularly from EU neighbours such as Germany.

3.15 *Science City York Recommends*

The consolidation of funding sources, and a longer life-span for awards and grants.

Targeting new resources on functional activities, such as promotion.

3.2 *Planning Guidance*

3.21 The uncertainty and delay by the planning system in responding to the need for suitable sites to be brought forward which could accommodate science-based growth and facilitate further growth is beginning to become restrictive on growth. This is partly due to the "lag time" in the drafting and approval processes of unitary development plans, which is considerably longer than the speed of development of many knowledge based companies.

3.22 Recent changes by DETR have been noted and welcomed; Planning Policy Guidance (PPG) notes 11 & 12 recognise the essential connection between planning policy and the development of business linked to the science and research base. In particular, the clear role defined by PPG 12 for local authorities to use these tools to encourage economic development through knowledge driven industries is one played successfully by the City of York in developing Science City York.

However, the time-scale for implementation may be too late for the forthcoming Green Belt Review in the City of York. The current Green Belt Review process in York will have a massive impact on whether the fast growing high technology clusters in York will continue to expand or not. Five local factors make this especially relevant for York:

3.23 The current demand for sites and premises from substantial surveys conducted by SQW within York high technology business, highlight that there are significant shortfalls in the short, medium and long-term in the provision of the quality sites that science/technology firms are demanding. The timescale for completing the Green Belt Review/Local Plan Process is incapable of meeting the requirements that are expected over the next three years.

3.24 The layout of the City means there is a lack of suitable brownfield sites held in reserve. The only large scale brownfield land opportunity, York Central, land north-west of the Railway Station, occupies approximately over 60 ha will only be suitable for approximately one third of Science City York firms (as defined by consultants SQW) and is unlikely to be brought forward for development before 2004.

3.25 The majority of the designated employment land held in reserve falls within the City's Green Belt, thus if the clusters are to develop as per the 25 year forecasts, the release of land over this timescale is required.

3.26 As a "new" university established in the 1960's, the University of York is located on the outskirts, surrounded by Green Belt. In order to achieve sufficient geographical proximity, necessary for successful cluster development and effective business incubation, there is no option but to take land out of the Green Belt.

3.27 Once employment land is allocated through the process, the current planning system provides only limited support for ensuring that the land can be used for the high-tech purpose for which it is intended—rather than being put to general B1 or B2 uses.

3.28 The planning process has the potential to aid the development of knowledge based industry, but at the moment it can be a significant barrier in the development of clusters, and in York we are specifically being held up by the Green Belt Review. We would like to see the Government be more pro-active in reforming the planning process in order to speed up timescales and thereby remove the current hindrance on cluster development. We would also recommend that the current definition of "employment sites" be refined so that land can be reserved solely for knowledge based industries.

3.29 *Science City York Recommends:*

A more integrated approach to planning and economic development to speed up the process to match the pace of growth in science based industries.

The special requirements of knowledge based industries to be recognised in the UDP land allocation process.

3.3 *The Private Sector and Cluster Development*

3.31 Private partners have been involved in the cluster development in York since the instigation of Bioscience York in 1995. They have helped in defining the direction of the project through the Science City York Advisory Group and have made a financial contribution to running the project, funding a Bioscience York executive staff post to support the development of interactions between companies through a series of working groups.

3.32 These working groups have examined areas for collaboration between partners including Nestlé R&D, CSL, Smith and Nephew Group Research, the University of York and Covance. Through sharing expertise through the Library and Information Services Working Group savings of over £60,000 per annum has been attained. Similarly the Procurement and Purchasing Group have purchased specialist equipment, such as mass spectrometers, to share between company research teams. The HR & Training Group were also successful in helping to ensure that a bid to the Competitiveness Fund for over £500,000 was invested into new HND bioscience technician training facilities at York College to support company's training needs locally. A new SME marketing and communications working group is shortly to be established to help bioscience SMEs with PR and marketing issues—which has been raised as a pertinent local issue facing their businesses.

3.33 Two of Science City York's key funding partners, the York Inward Investment Board Ltd and York Business Development Ltd are also from the private sector.

3.34 In addition to Bioscience York activity, each particular cluster (bioscience, e-science and heritage and arts technology) meets each quarter, to consider local initiatives and activities and to encourage networking between cluster members, with input from commercial and academic partners. Specialist advice is available in technology transfer, funding, start-up assistance, access to finance and venture capital, marketing, and international trade promotions from the Science City York Business Development and Promotion Team.

3.35 Regular "Business 2 Business" networking events are held bi-monthly on issues which are affecting clusters as a whole, the most recent session has examined at remuneration issues. Members of the cluster also have dedicated email listservers to post information of interest to other firms in their sector, for example the ICT community exchange information relating to the best deals in relation to internet and ASDL access through this service. The heritage and arts technology companies are also working together to support a bid to NESTA to help provide locally more specialist support for creative industries start-ups through a mentoring and funding scheme.

3.36 Private sector involvement in cluster development activity is at the heart of Science City York to ensure that services and initiatives delivered are beneficial to them. On the whole, most firms within each sector recognise the holistic benefit of them working collectively together on common issues which are relevant to their firms or to the community, for example on National Science Week activities. The key issue to maintain their support is for government to ensure that appropriate funding sources for business driven initiatives are sustained in the longer term and that they are to be flexible to adapt to changing business needs.

3.37 *Science City York Recommends*

A longer life-span for flexible awards and grants to support business-driven initiatives in order to sustain private sector support and enthusiasm.

3.4 *Universities and Cluster Development*

3.41 The underpinning of Science City York by the University of York, a research led university which is constantly ranked in the top-ten of the UK's leading Universities with world class departments of biology, chemistry and computer science, has been a major factor in the project's development.

3.42 The University already had a successful record in the commercialisation of research work and intellectual property. Many major global companies have already established research links with the University. Not only does the University provide spin out and start-up companies, but also high calibre graduates which top up the city's skilled workforce year on year.

3.43 The York Science Park, adjacent to the University's campus, offers opportunities for technology transfer through direct business links, access to facilities and joint venture opportunities. The initial phase began in 1992 with the location of the Smith & Nephew Group Research Centre. Subsequent development has seen mixed office and laboratory space for small technology-based companies, and a persistent demand for space will see a further development of 53,000 sq. ft. being made available. There has also been significant government investment through the location of MAFF's Central Science Laboratory in the City.

3.44 The University of York has been awarded the HEFCE Reach Out Bid. The £1.1 million, four year award will provide funding for five new key positions to facilitate interactions between businesses and the University. One of these positions, the Science City University Interface Manager will be charged with developing and enhancing technology and knowledge transfer between university staff and Science City York companies. This would complement existing business development activities which are already in place.

3.45 *Science City York Recommends*

The continual involvement of higher education institutions as an essential part of cluster development.

3.5 *Infrastructure*

3.51 There are two key infrastructure issues which we feel are missing from the White Paper, yet are creating tangible constraints on development of clusters, and knowledge-based industries in general. The first is the issue of property leaseholds for high technology companies who have out-grown incubator space. At present it is very difficult to obtain short leases, as is the norm in the USA—15 years is usually the minimum term sought by institutional investors. Yet the new knowledge-based companies Science City York is trying to encourage will not necessarily have the strength of covenant to make such an inflexible commitment.

3.52 The second point is the access to broadband telecommunications. The unbundling of the local loop in July 2001 is an encouraging development, and will deliver real benefits if, through more competition, it results in lower prices for "always on" connections. This is a major concern for e-Science York companies at the moment, for example one ICT firm within York has expressed the view that they are considering whether to expand their business in Manhattan, rather than York as the costs of bandwidth in the US are so substantially cheaper. We have been speaking to providers in York about bandwidth infrastructure, and at least one provider is keen to extend their fibre coverage in the City, however, ensuring that the unbundling of the local loop occurs at the pace required by high technology businesses ought to be a main priority for OFCOM.

3.53 *Science City York Recommends*

That developers are encouraged to offer shorter term property lets.

That the pace of change in opening up the local telecoms market continues to ensure lower bandwidth access costs.

12 January 2001

APPENDIX 64

Supplementary memorandum submitted by the Institute of Biology

SUMMARY

1. This response's principal contents include:

(i) the White Paper is greatly welcomed, and it addresses a number of key concerns

(ii) however, the White Paper does not go far enough to resolve a number of problem areas. These include the: pan-Departmental co-ordination and support (especially departmental investment) for UK science; and scientists' career structure (especially with regard to the dominance of short-term contracts)

(iii) that the failure to meaningfully address these concerns will result in the continued erosion of UK science and impede the UK from becoming a leading high-tech/high-income nation

(iv) this failure will severely hinder (and probably prevent) the UK from becoming more sustainable (both more self-reliant in terms of resource use (both natural and human)) and in terms of environmental quality.

GENERAL

The Institute welcomes the Science White Paper and looks forward to continued real-term investment in the Science Base, the proposed cross-departmental approach and its biological priorities.

2. The Institute welcomes the *Excellence and Opportunity* Science White Paper (2000) and its proposed initiatives. In particular, the reassurance as to the Government's appreciation of curiosity-driven (blue skies or fundamental) research (White Paper, paragraph 28). As such, we look forward to its continued increased real-term investment in the Science Base as a proportion of UK Gross National Product (GNP).

The Institute also welcomes the cross-departmental approach that is said to "underpin" the White Paper (White Paper, paragraph 31), the concern for the high proportion of researchers on short-term contracts (White Paper, paragraph 34), and the biological emphasis on funding priorities (White Paper, paragraphs 26 and 27).

Prior to the White Paper the Institute identified several policy concerns for the OST

3. Prior to the White Paper the Institute responded to the Office of Science and Technology's (OST) pre-White Paper consultation on Science and Innovation Strategy. In its response the Institute cited the following policy concerns:

(i) the need for a co-ordinated strategy across all of government, its departments and agencies;

(ii) the need for dedicated and well-trained scientists in providing excellence in science research;

(iii) the need to reverse the current discouragement for scientists engaging in scholarship activities;

(iv) barriers to inter- and multi-disciplinary research (but not to force partnerships that may be less than useful);

(v) the need to provide the tools for, and the reward of, excellence;

(vi) to reverse the decline in total governmental investment in science to its real-term mid-1980s level;

(vii) to note that some research is not suited to the three-year standard funding model;

(viii) free impartial advice and source of initial resources from a single source for start-up and/or spin out companies;

(ix) concerns over A-level science uptake;

(x) major concerns over the proportion of short-term contracts in research;

(xi) concerns over the current research assessments, for example not including industrially commissioned or orientated research and its output;

(xii) reforming the scientific advisory system and the need to make it easier for bench scientists to contribute their advice;

(xiii) the need to properly value advice from royal chartered bodies.

NB. The above strategies are in order of the OST's consultation questions and not Institute priority.

That many of the above concerns are shared by the White Paper is welcome, but action beyond the White Paper's proposals is required

4. The *Excellence and Opportunity* White Paper (2000) does address many of the above priorities, and this is greatly welcomed. However, in virtually all areas the White Paper does not go nearly far enough to meaningfully address the issues it raises.

Three fundamental priorities especially need to be addressed with urgency

5. Though all of the above concerns need far more attention given them, the following need special mention as requiring substantial attention:

(i) the balance of short-term contracts to fixed tenure (which for scientists with several years of proven track record generates an additional administrative burden. Also, in terms of costs to the UK, not inconsiderable personnel overheads associated with generating new contracts, advertising, interviews etc.) We note that this concern remains unresolved despite being highlighted by the previous 1993 White Paper, *Realising Our Potential* and being mentioned in a number of select committee reports

(ii) the need for proper strategic and budget control across departments so as to be able to implement a meaningful UK strategy for science

(iii) the need to return to the real-term, mid-1980s level of government investment in science and to maintain this as a proportion of the UK economy. Nowhere has the year-on-year decline in investment been so noticeable as with MAFF. This is all the more surprising given the often-stated political imperative to base policy on sound science. Yet despite issues such as salmonella, bovine TB, BSE, and GM crops/food, MAFF has devoted reduced resources in real-terms to research virtually every year since the mid-1980s.

Several consequences can be expected from failing to address these three priorities

6. If the issues in the above paragraph (6) are not fully and adequately faced, then we confidently predict that the UK can expect to see the following:

(i) the continuing decline in terms of the *proportion* of science A-level pupils continuing to study "core" science to BSc level—as science becomes less attractive as a career option. (While biology itself is currently doing well in these terms (compared to physics and chemistry), policy decisions need to be made as to the UK requirements for the balance between science and non-science bachelors' output, irrespective of whether a career in research is then followed);

(ii) the continuing decline in the best science graduates embarking on a career in science (for instance as revealed by the Save British Science survey of university departments);

(iii) the continuing decline in the proportion of top scientists (for instance as represented by the proportion of Fellows of the Royal Society) working within the UK;

(iv) continuing impedance to address policy concerns with a core scientific dimension to them (for instance as revealed by the recent Phillips Report);

(v) continuing pressure on the research councils to include policy-driven concerns (such as from Foresight) at the expense of blue skies or fundamental research. (Policy driven research needs to be led by government departments within an agreed strategy);

(vi) continued problems in transferring knowledge to the industrial-commercial sectors (as this should be supported largely by appropriate departments and not the Science Base; industry and commerce will only support close-to-market applied research);

(vii) the failure for the UK to become a leading high-tech, high-income nation in the 21st century;

(viii) the failure for the UK to become more sustainable (both more self-reliant in terms of resource use (both natural and human) and in terms of environmental quality). Indeed without the proper investment in, and strategy for, UK science will continue to become less economically and environmentally sustainable.

The UK bioscience community is actively identifying its priorities for UK science

7. Because we believe the concerns of the UK bioscience community must be taken seriously, the Institute of Biology has been surveying the views of its 76 affiliated societies. It has compiled these and, following a feedback ratification period with these societies, will be publishing a bioscience priority list for UK science policy in the Spring of 2001. It will be sharing these conclusions with those with a central role in UK science policy as well as its cousins, royal chartered bodies that relate to physics and chemistry within the Science Council.

12 January 2001

APPENDIX 65

Supplementary memorandum submitted by the Save British Science Society

1. SBS has welcomed both the increased Science Budget, and many of the proposals in the White Paper. The comments set out below inevitably focus on areas of concern, but they should be seen in the context of a positive attitude towards significant increases in funding for the Science Base for which SBS has campaigned for years.

EXCELLENCE AND OPPORTUNITY

2. The key element of the new White Paper is the first sentence of paragraph 9, which reads:

> "The importance of excellent, curiosity-driven research cannot be emphasised too strongly."

3. If this philosophy is now to inform Government policy as a fundamentai ethos, then British science is set to enjoy a new lease of life.

THE CURRENT STATE OF UK SCIENCE

4. The White Paper give a fair and reasonable summary of how Britain stands in the scientific world at present. Resting on a proud scientific heritage, we retain a strong scientific potential, and as SBS pointed out a little over a year ago[1], "if we handle change effectively, the UK is well placed to benefit greatly from developments in the science-based economy".

5. However, the UK cannot afford to be complacent. Our share of international science prizes has fallen in the last two decades, and the number of graduates in key disciplines, such as chemistry and physics, is also falling. The knock-on effects, for example in terms of recruiting physics teachers, are also worrying.

THE KEY PROPOSALS

6. The key proposals of the White Paper are all welcome. Increased investment in the science base, an explicit recognition that higher remuneration is one element of the package required to turn the brain drain into a brain gain, and a focus on enthusing young people about science, are all valuable.

BETTER SCIENCE IN SCHOOLS

7. SBS fully agrees that we need better science in schools, and set out several proposals in a symposium report entitled *Holding on to Excellence in the Science Base* during the summer of 2000[2].

8. However, we remain deeply concerned about the recruitment of qualified teachers, especially in mathematics and physics. The White Paper states that the Government intends to monitor the effects of offering £10,000 recruitment packages for teachers in shortage subjects. Since the publication of the White Paper, there have been strong signals that the packages are insufficient to stem the problem. In October 2000,

it was reported that the number of people registered to start graduate teacher-training courses in physics had dropped by 17 per cent on the previous year's figure[3].

9. It is clear that further action will be needed, other than that which is outlined in the White Paper.

Recruitment of Leading Researchers

10. Two schemes were announced in the White Paper aimed at offering better remuneration for researchers.

11. Increases in stipends for graduate students, together with the scheme announced in the White Paper, and launched in January 2001, to recruit a small number of the world's leading researchers into the UK science base, are welcome principally because they represent an explicit recognition that the "brain drain" is real and that remuneration is an important element of the solution.

12. SBS welcomes the fact that the allocation of the Science Budget, announced in November 2000, stated an explicit policy that the research councils have the freedom to pay more than the basic minimum stipend for PhD students if they deem it necessary, and we hope that the councils will take advantage of this freedom[4].

13. However, the schemes for doctoral students and senior high-fliers will affect relatively few people, and the bulk of researchers in the science base will remain extremely poorly paid by international standards, by comparison with their counterparts who leave science to work in other parts of the economy, and by historical standards.

14. This is the biggest disappointment of recent announcements. The extra investment in infrastructure, the attempts to reinvigorate science in schools, and the mood of positive appreciation of science and scientists, will all be devalued if the science base continues to suffer from inadequate salaries. The Department for Education & Employment's announcements of the budgets for universities over the coming years show that the Department is continuing in its failure to understand that researchers' salaries are one of the most important issues for the future of the economy.[5]

15. This is a subject on which the Select Committee has recently displayed a strong appreciation, and SBS hopes that the tone and content of recent exchanges with the Science Minister[6] will be fully reflected in the Committee's final report of the current inquiry.

Knowledge Transfer, Innovation, and Diversity in Higher Education Institutes

16. SBS broadly supports the Government's approach to providing opportunities for innovation in universities. In particular, we have welcomed the Higher Education Innovation Fund (HEIF), and its substantial growth over its predecessor, the Higher Education Reach Out to Business and the Community Fund (HEROBAC). In 1999, SBS said:

> "When it is proved to be a success on the current modest scale (which it undoubtedly will be), the Reach Out scheme should be expanded greatly...[but] not, of course,...at the expense of other funding streams."[1]

17. Thus, we fully support the White Paper's announcement that the HEIF will grow to be three times as large as HEROBAC, and that this is real new money. We hope that in time, it will be possible to expand the scheme still further.

18. We remain concerned, however, that links with the economy should not become too central a focus of too many higher education institutes. Universities are primarily places where new knowledge is generated, where existing knowledge is reinterpreted, and where people are educated and trained. Income from spin-out companies, licensing and other uses of intellectual property makes up on a tine fraction of total revenue, even in those American universities that are most successful at generating income in this way.

19. Thus, SBS welcomes the White Paper's insistence that UK universities should be able to operate according to a diversity of missions, allowing some institutions at one extreme to focus on leading-edge basic, fundamental investigations and academic teaching, while those at the other end of the spectrum concentrate on research of direct relevance to local business and industrially-relevant training. Other institutions will lie somewhere in the middle of the spectrum.

20. This philosophy will need to be backed up by the funding mechanisms, which must not distort this flexibility and diversity. In recent years, the Research Assessment Exercise has forced institutions to concentrate on one particular kind of output, to the exclusion of others.

Scientific Advice to Government

21. The White Paper's focus on transparency and accountability in scientific advice is a welcome continuation of changes that began with the publication in 1997 of the Chief Scientific Adviser's *Guidelines on the use of scientific advice in policy making*.

22. SBS remains concerned, however, about aspects of the advisory system. One concern, set out in more detail in paragraphs 38 to 41, is the serious decline in the budget for policy-led research in the civil departments.

23. Moreover, serious concerns about the scientific advisory systems have been highlighted by the BSE Inquiry, which uncovered specific evidence regarding problems with implementing regulations in abattoirs. Although the Chief Medical Officer considered that there was a risk to human health, civil servants prevented him from informing ministers about his concerns, let alone informing the public[7].

24. The Report of the BSE Inquiry recommended that scientific advisers should have a clear role not just as advisers within Whitehall, but also in advising the public directly. Importantly, it also found that the current system has permitted the "inappropriate use" of supposedly independent scientific advisory committees[8].

25 The ethos of openness that is set out in the White Paper will need to be rigorously enforced if such abusers are to be avoided in future.

SCIENCE BUDGET

26. SBS has wholeheartedly welcomed the announcement of significant increases in funding for the Science Base over the years 2000-01 to 2003-04. If similar levels of growth in the Science Budget can be achieved for a period of about a decade, then (taking into account likely changes in GDP) the UK would be investing in its Science Base at a level comparable to the average of other OECD countries.

27. The concerns set out in paragraphs 28 to 41 should be understood in the context of SBS's delight that UK Government investment in scientific research is increasing at roughly the level we have been campaigning for over a period of years.

THE REQUIREMENT FOR SUBSTANTIAL MATCHING FUNDS

28. The new Science Research Investment Fund (SRIF) represents a major injection of capital into UK science, and SBS sincerely hopes that it will enable the universities to begin to put right the severe damage that has been inflicted on the infrastructure of the Science Base over the past two decades.

29. Our principal concern is that the requirement for universities to find 25 per cent of the funds for any project from other sources may hinder the full potential of the £675 million that has been allocated to capital projects in universities.

30. Although the rules will not demand it, it is clear both from the amounts required (£325 million across the system) and from the comments of ministers[6], that it is intended that the bulk of the money will come from private industry.

31. The table below[9] shows that UK universities already raise more funding from private industry than their counterparts in other countries, relative to government investment.

Country	Business funding of R&D in higher education, as a percentage of the amount that is funded by Government
UK	10.1%
Germany	8.8%
USA	7.7%
Italy	5.0%
France	3.5%

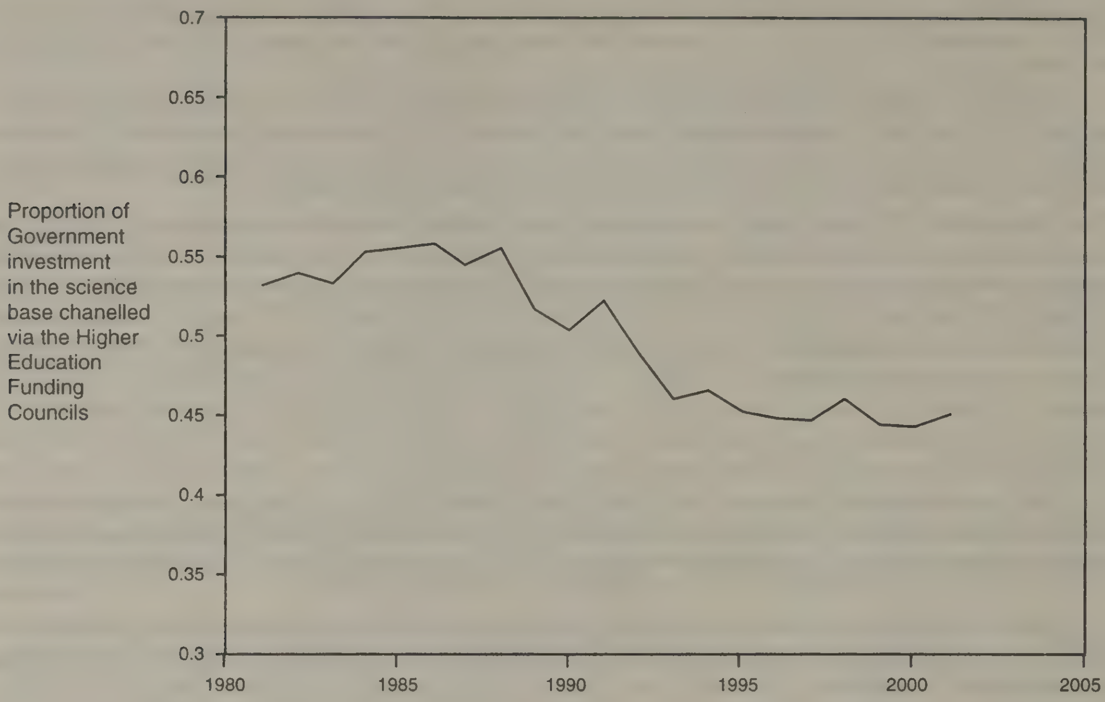
32. It may prove difficult to extract further large amounts of private investment in university research, at least on the timescale of the SRIF, unless extra incentives are offered to make it easier for industry to contribute.

33. It would be an unforgivable tragedy if the new scheme were to prove less effective than everybody hopes it will be, simply because the difficulties of raising matching funds could not be overcome in the two years during which the Treasury has made the funds available.

BALANCE BETWEEN THE RESEARCH COUNCILS AND THE FUNDING COUNCILS

34. The graph below[10] shows how the balance between research investment in the research councils and the funding councils has changed over the past 20 years, including estimates for the next two years based on the assumption that the Scottish, Welsh and Northern Irish Funding Councils will show the same proportional increase as the Higher Education Funding Council for England.

35. Quite apart from the deliberate transfer of funds within the dual support system (represented, for example, by the steep decline in the graph in the early 1990s), there has been a continued shifting in the balance of further for research away from the funding councils and towards the research councils.



36. The announcements in the recent Spending Review appear to confirm that the Government does not wish to see a substantial redressing of this balance.

37. This is unfortunate, because without substantial funds coming via the Funding Council route, the Science Base will lack the flexibility and freedom to make maximum use of the significant and welcome new money that has been made available.

DEPARTMENTS OUTSIDE THE DTI

38. Research and development in the civil departments is an important part of the Government's scientific portfolio. Although the research budgets of these departments are not formally part of the Science Budget, and although they have not yet been announced, there is already confusion about the changes that are likely to be made.

39. The Spending Review document talked about "anticipated rises" in the research budgets of the three departments that fund most scientific work—the Ministry of Agriculture, and the Departments of Health and of the Environment[11]. But at the same time, the then Chief Scientific Adviser appeared to cast doubt on these increases by saying that he hoped these budgets would stay "at least constant in real terms."[12]

40. More recently, in response to another of the Select Committee's inquiries, the Government has made it clear that there is not yet any clear view about the future research budget of the Ministry of Agriculture.[13] Not only is this uncertainty deeply unsettling for the scientific community, but, as SBS expressed in evidence to a previous inquiry, the continued cuts in the research budgets of the civil departments are deeply damaging.[14]

41. Moreover, they are not irrelevant to the budget of the Office of Science & Technology, as one of the research councils pointed out, when it described the cuts as putting "major pressure" on the Science Budget.[15]

CONCLUDING REMARKS

42. Overall the White Paper and Spending Review (and the Science Budget based on it) signal a move in the right direction for British science. But there remains a long way to go before the UK truly realises its potential.

January 2001

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6. Minutes of Evidence taken before the Science & Technology Committee of the House of Commons, 25 October 2000

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APPENDIX 66

Supplementary memorandum submitted by the Institution of Professionals, Managers and Specialists

EXECUTIVE SUMMARY

IPMS welcomes the White Paper and the general boost it gives to science in the UK. However, it pays too little attention to the role of science in government and the support of policy, especially on quality of life issues such as health, security and the environment.

SCIENCE FUNDING

Departmental funding outside the "science budget", which is the major funding source for public policy related science has declined over many years in both amount and proportion of departmental budgets. The 2000 budget has halted the decline, at least for civil departments, but a sustained increased will be needed to repair the damage done over the last decade and if the new Government S&T strategies are to be effective.

Although the Science Budget is generous for 2000–2004 overall it is below inflation in the first year. Funding for PPARC and NERC will actually decrease during 2001–2 which will exacerbate existing threats of redundancy and undermine the skills base which the rest of the White Paper is keen to protect.

IMPORTANCE OF SCIENTIFIC PEOPLE

We welcome the White Paper recognition of the vital importance of people and the wide role which government has in ensuring a sufficient supply of high quality staff and of the importance of "demand pull" or the "intelligent customer" for science in both public and private sectors.

The measures on the "supply" side are in general welcome, but the action signalled in the White Paper will not fully meet the identified need.

PAY AND CAREERS

The White Paper recognises that poor pay and careers, especially the widespread use of fixed-term contracts for scientists in PSREs and universities, are a major disincentive to choosing science as a career. Pay and careers must be improved and the forthcoming consultation on the EC Directive on Fixed Term Contracts used to maximum effect to improve the lot of those on FTCs.

Further efforts to improve the opportunities for both women and ethnic minorities are needed. Science must fully reflect the diversity of our society, as should the proposed science "ambassadors".

GOVERNMENT SCIENCE & TECHNOLOGY STRATEGIES

IPMS welcomes the proposal for government departments to develop S&T strategies based on the recommendations of the Council for Science & Technology. The implementation of the CST report should be an important catalyst in ensuring that the science strategies developed in departments focus on the policy-making, regulatory and "quality of life" functions which in most cases are their primary missions.

If the DTI is to fulfil its vital role in supporting innovation, both in government and outside, it must have a chief scientist to exercise a leadership role and increase the S&T staffing within DTI.

In the drive to "commercialise" public research outputs, mechanisms must be in place to ensure that roles and lines of accountability for "quality of life" issues and for "independent scientific advice" are clearly and transparently distinguished from those for industrial sponsorship.

The emphasis on government departments providing S&T strategies makes it even more important that the "Forward Look" should be published annually alongside "SET Statistics" and that the statistics themselves should be more meaningful for monitoring and review purposes.

INTELLECTUAL PROPERTY

IPMS fully supports the drive to maximise the effective dissemination and application of research results whether this be for public or commercial purposes. We welcome the White Paper's recognition of the need to protect PSREs and universities' objectives of "advancing knowledge and underpinning public policy". We agree wholeheartedly with the unequivocal statement in the White Paper that "IP policy must not undermine these aims and openness is paramount for research that supports public policy".

Where conflicts between the goals of advancing knowledge in pursuit of government policy and exploitation activity cannot be resolved, priority must be given to the primary goal of knowledge transfer and not to commercialisation.

Adopting a narrow financial approach may lead to under-valuation of research for the public good that does not have immediate commercial potential. This could have serious long-term implications for public science. Research providers should not be penalised for lack of commercial exploitation. There must be clear objectives for monitoring commercial exploitation; agreed indices; and a shared understanding of how the results of monitoring will be used.

There is a danger that the complex rules being proposed in the IPR Consultation Paper will involve a significant extra commitment of resources and even may impede the normal channels of diffusion and application or results. There should be regular monitoring of the new arrangements to ensure that the costs do not outweigh the benefits.

IPMS welcomes the intention that the IPR Guidelines should apply to all public sector purchasers of research and research providers. The management of intellectual property should be covered by a UK-wide framework.

TRANSPARENCY & DIALOGUE

IPMS has long advocated the need for greater transparency and dialogue in building confidence in science and innovation and generally welcomes the White Paper paragraphs on these issues.

A policy of openness will require additional resources and support in depth for scientific advisory committees.

It is vital that all experts advising government declare their interests and that all advice is open and subject to scrutiny by others. This should extend beyond financial considerations, bearing in mind that in the public sector scientific advice fulfils a variety of functions, not all of which have a clear commercial value.

The principles developed in "Guidelines 2000" and the forthcoming Code for Scientific Advisory Committees should be applied to all scientific advice, both at national, EU and international level.

If transparency and dialogue are to be effective, attention needs to be paid to the training, security, and rewards of the scientists who take part. It is also important to consider how best to organise the process to ensure that they do not result in reluctance to participate and that the ground rules and criteria being used in any particular context are agreed and clearly spelt out.

INTRODUCTION

1. IPMS welcomes this opportunity to supplement their evidence to the Committee on "Realising our Potential" which also enclosed the IPMS response to the DTI Consultation on Science and Innovation Strategy in January 2000, by commenting on the Science White Paper and the "Science Budget". We have organised our points in the order they appear in the White Paper, with supplementary notes on the Science Budget not covered in the White Paper.

2. In general we welcome the White Paper. Our main reservation is that it is overwhelmingly concerned with innovation in relation to industry and with the direct relationship between universities and industry. The third major player, government, and with it the public sector research establishments (PSREs), are seen primarily as midwife to the relationships between the other two. The amount of attention given to the role of science in government and the role of "evidence based" policy and promoting quality of life, is comparatively small. The fact that Chapter 4 on the key issue of public trust and confidence building is labelled "Confident Consumers" (our emphasis), is indicative of that approach.

Excellence in Science

World class infrastructure

3. We welcome the White Paper's recognition of the need for a strategy for national and international large infrastructure projects and the greater degree of certainty that a rolling ten year plan will provide(2.17)(1). As far as CCLRC(2.18) is concerned this is currently the subject of a quinquennial review. Stage 1 of the review has been completed and we know that a change in ownership structure is contemplated. IPMS agrees that the structure established under the 1993 White Paper Through which CCLRC is funded by the users, is not a viable mode of funding for such large scale and vital facilities and said so at the time. IPMS has not been allowed to see the proposals for change in ownership structure emerging from stage 1 of the Review until ministers have taken a decision. Given the complexities of the situation, especially in the light of the "Diamond" Synchtotron decision we believe we should have been able to have meaningful consultations on stage 1 proposals rather than face a *fait accompli* on which we will only be consulted on the implementation. We hope such an important set of facilities will be retained within the public sector.

Funding excellent research

4. The White Paper recognises that the Government has to be a key investor in basic science and outlines various expenditures, most deriving from the 2000 spending review, which are very welcome. In particular we welcome the £100 million in the Science Research Investment Fund for Research Council Institutes' infrastructure over three years. For the OST "Science Budget" this is another welcome boost coming on top of the previous CSR. However, the Treasury and other departments are still failing to address the rest of the departmental budgets which are crucial to government policy, statutory and regulatory support, as well as to the direct support of industrial innovation. For example Table 5 in Annex A shows that the proportion of the departmental budget spent on science engineering and technology (SET), already small, has declined by approximately one third since 1988 to a figure of 2.4 per cent in MAFF and 5.6 per cent in DTI.

5. The Baker Report said that commercial activities of PSREs should not be used as a substitute for public funding and a similar promise was made by Stephen Timms, Financial Secretary to the Treasury in replying to our response to the Baker Study which had been sent to him

> "I recognise that the core mission of PSREs is to undertake R&D for the Government. Increasing the commercialisation of PSRE research is an important step toward boosting innovation and productivity in the UK. But it is certainly not intended to be a means of substituting core funding. Indeed it is an important responsibility of government departments to provide adequate funding to support the research which underpins their policy objectives.
>
> I also recognise the importance of retaining the vital role of PSREs in providing the Government with independent advice on key issues such as public health, safety and security. It is paramount that commercialisation does not undermine this role, and this point will be well taken in developing the Government response to the Baker Report."

6. The figures in *SET Statistics 2000* show the decline in departmental expenditure over the last ten years. (See Annex A for a more detailed analysis of the statistics on departmental funding.) It also shows (Table 3 in Annex A) that there will be a real increase in expenditure next year but that for defence this will not be sustained for the following year. (This coincides with the likely launch of privatised DERA). Although it is pleasing that the decline has stopped, at least for civil departments, funding will need to be increased further and sustained at a higher level if the damage done over the last decade is to be repaired and the new Government S&T strategies (see later) are to be effective.

7. In paragraph 1.22 the White Paper fudges the position of the UK in the International R&D funding league table. In fact it has declined from being near the top to being near the bottom of the international league table on most R&D funding measures. But it does recognise that the position of the UK is not good by comparison with its major competitors (see Table 8 in Annex A). It is therefore very welcome to see that the Government is not complacent on the issue. The recent investment in the science infrastructure already provides an excellent start in addressing the backlog but will need to be sustained at a high level if the UK is to remain internationally competitive. Research across G7 countries shows a statistically significant correlation between government investment in R&D and business investment in R&D where both are adjusted for the size of the workforce. So investment in both need to move together.

Funding Priorities

8. IPMS welcomes the thematic approach to priorities and in particular the recognition that "basic technology" is a key dimension of the Science Base. Highly skilled technical support, such as that found in research councils CCLRC and PPARC, is crucial. Along with this must go the recognition of the need for long-term and high quality staffing of technical support. In this regard we would draw attention again to the study by Dr Stephen Lipworth of the Royal Society on *Technical and research support in the modern laboratory* published in September 1998. The report said there was a real danger that any further decrease in numbers of core technical and research support staff, and the substitution of staff on short-term contracts will lead to a reduction in the quality of UK scientific research. It said that to achieve the objective of establishing and maintaining a "core" group with relevant expertise requires a career structure and training for all levels of technical and research support staff. The supply of such staff is also endangered by developments in PPARC where the cost of joining ESO is likely to result in cuts in ground based astronomy and its highly qualified technical staff in the UK and elsewhere.

9. We are concerned that although the "Science Budget" is generous for 2001–2004 overall it is below inflation in the first year. In the year 2001–02 the increases for research councils BBSRC, NERC, EPSRC and PPARC are below inflation. Indeed funding for PPARC and NERC will actually decrease during 2001–02 which is likely to exacerbate existing threats of redundancy. (See Annex A Table 2 for details.)

People

10. We are pleased to see the recognition of the key importance of people in the White Paper. It says

> "...the real core of the science base is people—teachers, students, researchers. 2. Government has a key role in creating Britain's basic scientific capability. Government is the lead investor in basic scientific research. Through education policy Government and the devolved administrations have a critical influence on the teaching of science. As an employer of thousands of scientists in public research laboratories Government influences the rewards available for science. Government needs to be an intelligent investor in science, determined to promote excellence and diversity and provide opportunities for everyone". (para 2.2)

However, we are disappointed that very little mention of these issues are made in the key principles in Chapter 1. The action signalled in the White Paper does not match the analysis of the importance of the issue nor does it fully meet the identified need.

11. We are pleased to see that the White Paper does not take such a rosy view of the supply of S&T staff as the original consultation paper did. It recognises there are problems of supply and makes some suggestions as to how these should be tackled. But the "demand" side—the "intelligent investor" in science also needs to be addressed as well as the "supply side", a point which the White Paper recognises, for example, in paragraph 3.12 on "stimulating demand from business". As the above quote shows, the Government has a key role. For this to be performed effectively not only requires a specialist S&T "customer" capability within government, it also requires a much greater general awareness of S&T issues among "generalist" decision makers in many departments and a much better career path for S&T specialists to be promoted and recruited into these more "generalist" positions. Similar pathways are required in the private sector (paragraphs 27 and 28).

12. On the "supply side" IPMS welcomes the steps set out in the White Paper (2.8–14) to encourage more students to take up science as a career. We would like to see government and research council establishments playing a full part in these efforts as some already do and being provided with the resources to carry it out effectively. We also hope that government and research council staff will be able to act as science "ambassadors". Such "ambassadors" should also be fully reflective of the school population in terms of both gender and ethnicity. As the White Paper acknowledges there are still major problems in attracting women to science, particularly outside the life sciences, and there are also problems, although not covered by the White Paper, of low take up of science subjects by British Afro-Caribbeans which need to be addressed(2).

Academic Rewards

13. Just as important, however, is the issue of rewards. As the White Paper says "people who want to do science also need to be able to afford to do it". Poor pay and career prospects are an important disincentive to people to choose science subjects at university and to choose "core" science jobs once qualified.

14. The White Paper begins to address this in the university context with its proposals to increase the basic PhD stipend to £9,000 p.a. by 2004 and to launch a fund to assist in the recruitment of up to 50 leading researchers to compete in the world market for the best academics. But it says nothing specific about academic salaries (which have fallen 36 per cent since 1981) or other areas in the public services. For example, there are severe recruitment and retention difficulties among S&T staff in the civil service and research councils. Examples include BBSRC which has major problems in recruiting post-doctoral project leader scientists and where many scientific and support staff are leaving for better paid jobs in the private sector. Research councils and many government departments have difficulties in recruiting and retaining IT specialists. NERC has introduced special fellowships for research on the environment in order to address a shortage of

environmental scientists with mathematical, computational and statistical skills. Nor is the private sector immune from these pressures as chapter 3 of the White Paper (3.15–16) shows.

Fixed Term Contracts

15. The White Paper recognises that fixed term contracts are a major disincentive too. While we welcome measures outlined in the White Paper (2.35) they do not go far enough. We know that Lord Sainsbury does not support the use of FTCs as a normal mode of employment and welcome his statement in the debate in the House of Lords on the White Paper that "As regards short-term contracts, we are keen to reduce their number. There is an initiative to introduce more long-term contracts in universities".

16. We would urge the Government to reflect this policy in their implementation of the EU Directive due to be implemented by July 2001 on which DTI is currently formulating its consultation paper. Our information from preliminary discussions is that the Government is considering excluding pay and conditions all together from the scope of the directive. We and other trade unions who have significant numbers of FTCs in science will be resisting such a move which would nullify any significant impact the directive might have.

17. We would also like to see redundancy "waiver" clauses outlawed. In the meantime, the Bett Committee (Independent Review of Higher Education Pay and Conditions) recommended that those on fixed term contracts of more than a year should be eligible for redundancy pay and the universities are being encouraged to adopt this. We would encourage research councils and government departments to do the same for their staff and to adopt the measures in paragraph 2.34 where they are not already doing so. Positive incentives similar to those which the White Paper proposes for universities would help to expedite the adoption of best practise.

Improving opportunities for women

18. The continued under-representation of women in S&T, particularly at more senior grades, is a longstanding problem and already well documented in 1994 in the Report "*The Rising Tide*"(3) produced following a government working group on which IPMS was represented. As shown in research by Fielding and Glover(4), women in S&T are likely to face gendered job ladders, lack of access to training, disregard by employers for equal opportunities, hostile workplace culture, and requirements for geographical mobility. The issue of work/life balance is a key issue and the "long hours" culture present in many jobs, particularly those at senior level, has its parallel in the "24 hours commitment" which is seen as the keystone of a committed scientist and relegates those who work part-time or want a reasonable work/life balance, whether they are male or female, to second class status. Women also tend to be over represented among FTCs which provide their own barriers to advancement such as the requirement in many areas that only permanent staff can bid for research contracts.

19. These points are confirmed by the recently published report *Who Applies for Research Funding*?, commissioned by the six research councils together with the Wellcome Trust. This shows that women are less likely to be eligible to apply for grants (except from the ESRC). Reasons why women apply for fewer grants include:

- staff at senior levels applied for more grants, but women hold just one fifth of senior posts
- full-time academics are more likely than part-timers to apply for grants and women are more than twice as likely as men to work part-time
- those with tenure apply for more grants—more women than men have fixed-term contracts
- women are less likely than men to be involved in high-profile research or to have a high publication record
- women receive less institutional support
- career breaks have a considerable impact on grant applications
- fewer women with dependent children apply for grants than men in the same situation.

The report recommends a review of funding policies by the research councils and the trust, and urges universities to rethink their employment practices.(5)

20. The "*Rising Tide*" made many recommendations and established a Unit for Women in SET in the OST. Some progress has been made and several new initiatives started as the White Paper recognises, but as the research quoted above shows there is still much more to be done.

21. We welcome the new target of 40 per cent membership of SET related public bodies to be women by the year 2005 (2.38). Similar targets need to be established for senior positions in all organisations in both the public and private sectors. In the Civil Service a new impetus to the effort to achieve equality is being given by the "modernising government" programme and the fact that "a dramatic improvement in diversity" is one of the six key themes. The report to the Prime Minister by the Head of the Civil Service set out the following targets for the senior civil service objectives and targets with associated action plans in grades below that level are to be set by departments, with permanent secretaries accountable for delivery on diversity.

per cent	*1998 (actual)*	*2000 (actual)*	*2004–05 (Target)*
Women	17.8	22.1	35.0
Ethnic Minorities	1.6	2.0	3.5
People with Disability	1.5	1.7	3.0

22. These targets refer to civil service staff as a whole, of whom SET staff are only a small minority. It is important that SET staff are fully integrated into the action programmes and that the statistics are made available to ensure that is the case. SET staff in general and women and ethnic minorities in particular should be fully represented in the drive to secure a service more open to people and ideas and which "brings in and brings on talent". IPMS has made detailed comments to OST on how these objectives would be achieved as part of their departments' S&T strategies.[6]

Attracting scientists and engineers to the UK

23. We have several comments on the proposals to enable overseas students to apply for work permits in the UK without having to return home first. (2.39). These are that:

- this should not be a substitute for solving the problem lying behind the reluctance of UK students to take up scientific careers;
- the issue of university fees is a further inhibiting factor for UK students (outside Scotland), particularly for lower income groups, and should be tackled as a priority. Even more worrying is the possibility that universities may charge students higher fees where graduates are expected to earn higher salaries such as engineering and technology. This could further exacerbate the problem of supply;
- there are also problems for British citizens previously resident abroad who can only claim UK rather that overseas fee rates if they have been resident for three years for non-study purposes; and
- there is a moral problem of potentially depriving poorer countries of qualified staff, especially if their government has provided the fees.

24. We understand from press reports[7] that the White Paper proposal has been implemented and that the Government is examining whether the entire immigration system should be ovrhauled to help address the skill shortage in a more strategic way. While IPMS would support a more liberal approach to cross border mobility in general, we would urge that the whole range of issues oulined above should be reviewed in order to avoid new anomalies and to ensure that efforts to increase the supply of SET staff within the UK are not neglected.

OPPORTUNITIES FOR INNOVATION

Foresight

25. We welcome the £15 million Foresight Fund (3.3) designed to aid technology transfer. This is particularly important in areas such as agriculture where small units predominate. However we are still concerned that employees are not sufficiently well represented on Foresight panels. For example the Food Chain and Crops for Industry Foresight Panel, during the presentation of its report on 6 December 2000 at the DTI, made a particular point about its lack of information on how to address the improvement of skill levels in the food chain and to make it a more attractive career. There were no trade unions or any other people who might put an employee point of view on the panel or any of its task forces to help address such questions, although nominations had been put forward. One of the recommendations of the Panel is that the DfEE should consider how to establish a Food Chain Skills Forum for targeted action to improve skills in the food chain. We would suggest that maybe union representatives might be included on this occasion; and included when the panels and task forces are next refreshed.

Universities in the knowledge driven economy

26. Our main concern as far as universities are concerned is that, as in the case of PSREs, the emphasis on commercial exploitation should not distort the core mission of universities in relation to basic research and teaching and that their "independence" and ability to disseminate knowledge freely in universities do not become too greatly inhibited. While the percentage of private industry expenditure taking place is currently only 7.2 per cent of the total on R&D, that figure already outstrips the USA where it is 5.8 per cent and although that might be a cause for congratulation as far as the White Paper is concerned, the balance needs careful monitoring.

Stimulating demand from business

27. The main challenge is to encourage businesses to recognise the value of R&D to their competitiveness and the White Paper identifies this is vital.

> "12. As well as universities reaching out and transferring their knowledge to business, we need more companies to use science and technology to create competitive advantage. Our record on this is still very weak. Too many of our companies still lack awareness of the need for change, or the ability to do so. In many industries we invest less in research and development than our competitors, and our companies are less ready to change and innovate than others. This is particularly true of large firms."

28. If the intelligent investor in R&D is to develop within companies, however, it is important to nurse internal SET talent. Outsourcing their R&D, as many companies do, will not help to fill that need.

Regional clusters and innovation

29. IPMS support the concept of clusters and the promotion of regional development and the importance of providing a "critical mass" of scientific activity regionally and locally and to build up links between universities, PSREs, RTOs and local business. Indeed the argument for building the new "Diamond Synchrotron" at Daresbury rather than Oxfordshire was that, the scientific argument for the two sites being equally balanced, the regional scientific impact at Daresbury would be much greater.

30. However, we are concerned that the establishment of a new Regional Innovative Fund will fragment funding further. The greater the multiplicity of funding sources, the more complex and resource intensive it becomes to administer and to access them. Much R&D is national and increasingly global in its implications rather than regional. We are therefore not sure that funding should be provided for R&D on that basis, or at least it should not be provided to the detriment of the overall level of funding of the science and engineering base.

31. The problem of fragmentation of resources into small packages to the detriment of more long term funding applies to the whole range of innovation funding. We agree that the programmes should be flexible and able to meet a variety of circumstances. But the schemes should be clearly explained, advertised, and accessible, preferably with a "one stop shop" approach, particularly for SMEs. It is essential, however, that those giving guidance are knowledgeable in depth about the schemes and the technology or have easy access to those who are. For SMEs in particular the delivery should be as simple and direct as possible.

Strategies of government departments

32. We are very disappointed at the almost exclusive emphasis on commercial innovation in the short reference which the White Paper makes to the need for and the role of government science and technology strategies. In paragraph 1.12 of the White Paper it says it is the Government aim "to allow scientific know-how to flow beneficially through to society, into business and jobs, and also into healthcare, public services and the environment". (our emphasis). But there is little acknowledgement of the latter in these paragraphs, nor is much attention paid to the importance of innovation and its diffusion from R&D in those areas unless they have a commercial application.

33. In fact the CST Report on "*Scientific Activity Across Government*", to which the White Paper refers, is primarily concerned with the decline in government capability in SET, of which industry and innovation strategies are only a small part. It says:

> "7. In the course of our review it became clear that overall the Government attaches considerable importance to the way in which S&T are used by departments. We saw examples of good practice in all the departments we visited, but we were not convinced that any department was really staffed, organised, or sufficiently aware to make the best possible use of science and technology in delivering their short and medium term objectives and targets, and in formulating their strategy for the longer term. We are concerned that the resulting weakness in their ability to understand, and to respond to, rapid change in the external work create increasing risk that wrong decisions will be taken, with potential for substantial damage and costs to Government and Society".(8)

34. This is partly the result of the continuous cuts in funding and staff over the last decade or so (see Annex A, Table 9). But also it is the result of privatisation and fragmentation which the CST Report acknowledges has cut off a major source of SET staff for core departments' policy making and other functions.

35. The Government held over the publication of its implementation plan for the CST Report's recommendations until the White Paper was published. In the comments which IPMS has put to the OST on how the recommendations should be implemented, we say that we hope that the CST report and its implementation will act as an important catalyst and counterweight in ensuring that the science strategies developed in departments do focus on the policy-making, regulatory and "quality of life" functions which in most cases are their primary missions and do not get completely hi-jacked by the commercial innovation emphasis in the White Paper. Also the required resources will need to be put in place for the science and technology strategies to be effective and to put right the losses to capability resulting from the previous

policies of privatisation of PSREs and cuts in S&T funding. We agree with the view of The Royal Society that "It will be difficult to arrest and reverse this damaging drop in R&D expenditure unless each government department accepts that its policy objective depends upon a world class Science Base. Each government department should then include support for a world class science base in its Mission, and should invest accordingly"(9). Departments are due to produce their strategies by the end of 2000 for implementation in April 2001.

36. As far as the development of innovation and use of SET in industrial sponsorship are concerned we have made the point that at least one of the original chief scientist posts in the DTI should be restored, enabling them to concentrate on the role of SET in innovation and the major role which the DTI should play in this. This would also release the Chief Scientific Adviser in the OST/Cabinet Office to concentrate on general scientific advice to government and the co-ordination of SET policy across departments. The loss of SET numbers in core DTI and the privatisation of its four major PSREs (NPL, LGC, NEL and, Warren Spring), leaving small NWML (also recommended for privatisation on the latest quinquennial review) in-house has left DTI poorly equipped to lead on the innovation strategy as it should be doing.

37. The CST Report focuses on four government departments with the largest S&T expenditure in addition to the DTI, namely MOD, MAFF, DETR and DH and all of these either have (eg MOD and MAFF), or could have, a major industrial sponsorship role. In all these cases, however, there is a potential for conflict between the department's primary mission and the role of industrial sponsorship or "commercialisation". This has already caused major problems of alleged conflict of interest in MAFF, for example in relation to both BSE and GMOs and has the potential to do so in DETR and DH. It is vital therefore that mechanisms are in place to ensure that roles and lines of accountability for "quality of life" issues and for "independent scientific advice" are clearly distinguished from those for industrial sponsorship and that there is transparency in the decision-making process within and between departments and in government as a whole.

38. IPMS has highlighted this issue many times in evidence to select committees and in submissions to the OST and elsewhere. It also has held a conference on the issues of science advice and integrity(10). We are very pleased to see that these issues are now being tackled, and the prominence given to the issue in chapter 4 of the White Paper. We do, however, still have major concerns that the drive to "commercialise" PSREs and promote industrial innovation by departments may compromise their core missions if not carefully monitored and managed.

39. The White Paper quotes the example of the Defence Diversification Agency and its role in regional development. It is not clear how well the DDA will be able to fulfil its equal access for all regions remit; nor indeed what its remit will be in general after privatisation. It is not yet known whether DDA will stay with MOD or go with the privatised DERA. If the former, it is not clear how it would develop its links with industry; if the latter, what would be the incentive for a privatised DERA to build up its competitors. Whatever the outcome, it is important that it should be able to continue its "mission of providing a world class innovation brokerage service benefiting small and medium sized firms".

40. The White Paper mentions that under its Small Business Research Initiatives (3.33) it will be opening up to SMEs' R&D procurement programmes worth up to £1 billion with the target of providing £50 million worth of research under these programmes from small firms. Each participating department will aim to provide at least 2.5 per cent of their relevant requirements from small firms. It is not clear whether "new" money will be forthcoming for this but it is important that it does not divert further money from PSREs which are already under enormous funding pressure.

41. The emphasis on government departments providing S&T strategies makes it even more important that the "Forward Look" should be published annually alongside "SET Statistics" and that the statistics themselves should be more meaningful for monitoring and review purposes.

Intellectual property: changing the rules

42. The effective dissemination of research results for application or exploitation, whether this be for public or commercial purposes, is vital and IPMS fully supports the drive to ensure that maximum use is made of research results. We welcome the White Paper's recognition of the need to protect PSREs' and universities' objectives of "advancing knowledge and underpinning public policy". We agree wholeheartedly with the unequivocal statement that:

> "IP policy must not undermine these aims and issues like whether to disclose any results before patenting require careful consideration. Openness is paramount for research that supports public policy" (3.35).

43. In many areas of government and university research the scope for commercialisation of research output will by very limited. As shown in our response to the Patent Office consultation on "Intellectual Property in Government Research Contracts: Guidelines for Public Sector Purchases of Research and research Providers"(11), most departments' primary purpose is general research and policy support. For example, over two thirds of SET expenditure in MAFF and DETR and 100 per cent in the HSC is in support of policy. (See Table 6 in Annex A).

44. That said, IPMS accepts that PSREs should have an explicit mission to exploit IP generated in research where it is appropriate for them to do so. We have been actively involved in consultations on the Baker Report(12) which was published alongside the White Paper and on the new Codes of Practice governing commercial activity by scientific civil servants and will not repeat the points we have made in detail here. But there are several points, worth emphasising from our submissions in this context particularly on IPR.

45. IPMS agrees that public sector purchasers should have clear IP strategies and management plans. We welcome the recognition, both in the Baker Report and the Science White Paper, that additional resources will be needed to ensure that expert advice is available to all research purchasers. It is very important such advisory facilities are located within government and that they are properly resourced. Part of the remit should be to encourage the spread of good practice across the public sector. By contrast, private sector advice is likely to be both more *ad-hoc* and more expensive.

Balancing the needs of public purchasers' and "providers"

46. The guidelines note that the primary goal of research in advancing knowledge in pursuit of government policy, regulatory and other official objectives may conflict with exploitation activity. We agree and accept the need where possible for such conflicts to be resolved without damaging either goal. However, it may not always be possible to have a conflict resolution that meets all needs. The requirements for exploitation are very different to those for providing policy or regulatory advice. There must be a clear recognition that, in such cases, priority must be given to the primary goal of knowledge transfer and not to commercialisation.

47. We agree the need for a culture shift towards a general assumption that public providers such as PSREs should own their IP. The guidelines suggest that this should be subject to the public sector purchaser securing adequate freedom to use the results for its purposes. This strikes a reasonable balance, though the issue is wider than simply allowing purchasers to be able to use a specific piece of IP. It is also important that they should be able to retain "intelligent customer" capability in-house for future work. The guidelines take a more flexible approach than the Baker Report in recognising that there are causes where this will be appropriate and this is to be welcomed.

48. However, the guidelines' proposal that public sector purchaser should retain a strategic responsibility for monitoring the extent of exploitation undertaken by research providers does pose difficulties. Whilst recognising the need to assess how well the new arrangements are working, there is a danger that this provision will create a stick with which to beat research providers. Indeed the guidelines suggest that failure to exploit might be taken into account in the award of new contracts. There is a real danger that adopting a narrow financial approach will quickly lead to under-valuation of research for the public good that does not have immediate commercial potential. This could have serious long-term implications. Government is unlikely to prioritise its own investment in such areas of research. It will be much easier to justify funding for research where there is a clear route to exploitation.

49. These outcomes will only be avoided if there are clear objectives for monitoring, agreed measures, and a shared understanding of how the results of monitoring will be used. In the light of the recognition in the guidelines that exploitation of research is a secondary goal and there is not always a commercial market for the product of research, it would in any event be more appropriate to focus on the effectiveness of technology transfer rather than on the financial outcomes of exploitation. Research providers must be judged by the science they produce, which is their core function. Exploitation may in some cases be better progressed through a different mechanism.

50. The Consultation Paper from the Patent Office demonstrates that the process of devolving IP, while safeguarding the legitimate needs of "purchaser" departments, is far more complex than originally conceived by the Baker Report. For example it requires complicated licence rights, and suggests "march in" rights in the event of the failure by the provider to exploit research. Meeting these conditions may well involve a significant extra commitment of resources and it must be seriously questioned whether the benefits will

outweigh the costs. It may be that a pragmatic case-by-case approach could better achieve the objective of promoting dissemination without the need to create a whole new legalistic system. Such an approach may work when applied to the commercial sector but it is much more difficult to define the "business needs" of government. The "business" of government is fundamentally different from that of a private company in at least two respects. Government must be able to respond rapidly both to meet unforeseen circumstances and changing political priorities. At the same time, it needs to take a long-term perspective beyond normal commercial timescales.

51. Nonetheless, if a decision is taken to proceed with this approach, there is no doubt that PSREs will require access to advice within government in order to successfully navigate the new requirements. Even so, the time and cost involved in obtaining advice may influence the viability of smaller projects. Granting perpetual licence rights may in some cases impede the process of exploitation, so there will need to be an appeals mechanism for research providers. Above all, any new arrangements along these lines must be regularly monitored to ensure that the benefit continues to outweigh the cost.

Openness and Publication Policy

52. The draft Guidelines state that underlying data and methodology of research used to support policy-making and regulatory decisions should be published. IPMS agrees that this should be the case and supports the May Guidelines on Science Advice. A strong lead is needed from senior levels within government to ensure that openness becomes the norm. Furthermore, it is important that information that is made available for public policy reasons is both widely accessible and meaningful to lay people.

53. The draft Guidelines also require PSREs to establish a publications policy and to consider results for patent protection before publication. This will change the ways in which public sector research providers currently work. For example, evidence from the university is that priorities and practices of researchers have changed and a whole new body of work has emerged simply to secure patent applications. In addition, competition between researchers has increased. Instead of seeking to be first to publish, publication is now being restricted until IP has been secured. This has had a consequential impact on the content of published papers with a growing tendency to exclude conclusions and speculation about future development as such material often become prior art for subsequent patent claims. Similar pressures are already evident in PSREs.

54. For example an IPMS survey of members engaged in R&D undertaken in February 2000 showed that 30 per cent of respondents had been asked to tailor their research conclusions or resulting advice, 17 per cent had been asked to tailor their work to suit the customer's preferred outcome, 10 per cent had been asked to do so in order to obtain further contracts, and 3 per cent has been asked in order to discourage publication. In addition a greater proportion of respondents found it difficult to maintain independence from their sponsor than found it easy(13). Serious questions must be asked as to whether such practices are in the public interest. But pressures to engage in them may be increased by adoption of the draft Guidelines. The recognition in the Guidelines that it may be necessary to treat commercially valuable results as confidential information shows that concerns about increasing control of the research agenda by sponsors are well founded. There is little doubt that in this context pressures to generate additional research will become the priority and that bland reassurances about the primacy of knowledge transfer will carry little weight.

Scope

55. IPMS welcomes the intention that the IPR Guidelines should apply to all public sector purchasers of research and research providers. We are strongly of the view that management of intellectual property should be covered by a UK-wide framework, though it will also be necessary to take into account the implications of the proposed common European Community patent (3.48). Care will also be needed to ensure that a level playing field is maintained in relation to exploitation of intellectual property rights (IPR) by private sector companies. The investigation by the Audit Commission of exploitation by PPL Therapeutics of gene transfer technology originally developed by BBSRC's Roslin Institute illustrates the potential pitfalls for the UK of an approach to exploitation that is more open than elsewhere in Europe or the USA.

Staff incentive schemes and management of conflicts of interest

56. The new OST Guidance on this subject provides a useful foundation, thought its operation will need to be monitored and reviewed on a regular basis. As set out in our response in the Baker Report, IPMS agrees that conflicts of interest must be managed on the basis of robust and transparent procedures based on active disclosure of interests, review of interests in terms of their materiality; and mechanisms to handle conflicts when they arise. We are aware that BBSRC has established a register of interests in all its institutes and that there is a widely drawn requirement on staff to provide details of any shareholdings in companies engaged in relevant activities. There is an active process of annual review and a procedure for joint review of potential conflicts of interest. We welcome this broad approach, though we would emphasis that conflicts should not be viewed solely in financial terms.

57. Steps should be taken, in consultation with trade unions, to encourage the adoption of similar provisions in other public bodies. These will need to be written in terms that are appropriate to the

circumstances of particular organisations. The rules need to be made clear to all parties from the outset and should exclude longer term reward for individuals who have left the employment of the organisation before commercial returns are realised. The rights of individuals not to waive their rights to exploitation income should also be clearly stated. There will, however, need to be sufficient flexibility to ensure that intellectual input can be retained within the parent institute, and there should be a right of return for staff encouraged or required to transfer to spin-off companies.

Confident Consumers

58. IPMS believes that the restoration of public confidence in science and government's handling of scientific issues is vital to securing public support for the required investment in R&D and the "knowledge economy". IPMS has held conferences and contributed to consultations on the issues, including the latest one referred to in the White Paper on a Code of Practice for Scientific Advisory Committees.[14] IPMS has long advocated the need for greater transparency and dialogue in building confidence in science and innovation and generally welcomes the White Paper paragraphs on these issues.

An Independent and Transparent Framework

59. The structures and resources will need to be extremely robust especially since the areas currently likely to show greatest benefit in both economic growth as well as quality of life such as genomics also pose the major ethical and social dilemmas and in some cases risk. They will also require prioritisation in the face of limited resources for research exploitation which is a democratic as well as a technical issue. Moreover the process of creating an independent and transparent framework and the Government ensuring that "risks" have been properly assessed and controlled, and in communicating those risks clearly and simply, and at the right time (4.16), can be very resource intensive.

60. Thus, for example, in addition to the need for basic research (4.18), which is needed to cover both known and yet unknown sources of risk, there is the need for greater scientific research support in depth for scientific advisory committees so that they can test the evidence more thoroughly themselves. Whereas at the moment they are often highly dependent on evidence provided by companies' own researchers when testing the safety of products.

61. It is vital that committee secretariats are scientifically literate and that they are adequately resourced at all levels. The duties of secretariats extend beyond processing papers for committees. For example, they should be able to assess and advise on papers provided for committees. Secretariats have a key role in managing committee business, ensuring probity, and in providing a link back to policy makers in government departments. A useful framework is set out in the Medical Research Council's code of ethics for management and administration of scientific committees. The BSE Inquiry Report highlights the need for government departments to retain "in-house" sufficient scientific expertise to enable them to understand and review advice given by advisory committees (paragraph 1279).

62. The way in which committees use research will be critical in engendering confidence in their work. This may mean that more explicit acknowledgement needs to be given to areas of uncertainty and to communicating degrees of uncertainty in committee findings. It is clear that committee members should not use their position simply to "corner extra funding" for their research group or laboratory. However, it should be recognised that committee members may be drawn from centres of excellence which may be very well placed to progress research in specific fields. As is the case for appointment of committee members, it would not be in the public interest to ignore the best quality research providers. However, it will be necessary to have a procedure for managing conflicts of interest in such circumstances.

63. IPMS views on how conflicts of interest should be managed are set out in detail in our response to the Baker report. We believe that it is vital that all experts advising government declare their interests and that all advice is open and subject to scrutiny by others. This should extend beyond financial considerations, bearing in mind that in the public sector scientific advice fulfils a variety of functions not all of which have a clear commercial value. In such circumstances, a more positive and proactive approach to sharing of research should be promoted. Elsewhere, there is much to be learned from procedures and practices adopted overseas, for example in the USA. The principles developed in "Guidelines 2000" and the forthcoming Code for Scientific Advisory Committees should be applied to all scientific advice both at national, EU and international level, for example the Codex Alimentarius.

64. Greater transparency, inclusiveness and dialogue as advocated in the White Paper also have important consequences for scientific staff which go far beyond simply better communications, important though these are. Scientists involved in research which is of public interest or controversial, are being called upon already to justify their views and account for their actions in ways which are not always going to stick within the confines of "a mission to explain". Also they are exposed to danger from militant protesters in some areas.

65. As the BSE Inquiry has shown scientific professionals and advisors are being expected to give advice to administrators and politicians going well beyond their technical expertise alone. Many IPMS members involved as witnesses in the BSE Inquiry are extremely concerned at the procedures used in the inquiry such as the instant transmission on the internet of witness statements and its failure to take into account the

broader political and civil service context in which their individual roles were played out. Recent press reports have also drawn attention to the fact that scientists are now much less willing to serve on the scientific advisory committees because of the high profile exposure and the broader role which they now appear to be expected to fulfil.

66. If transparency and dialogue are to be effective, therefore, attention needs to be paid to the training security, and rewards of those who are expected to play the new roles. But it is also important to consider how best to organise the process to ensure that they do not result in reluctance to take part and that the ground rules and criteria being used in any particular context are agreed and clearly spelt out.

12 January 2001

NOTES AND REFERENCES

1. These references refer to paragraphs in the White Paper. Thus 2.17 means chapter 2 paragraph 17.

2. IPMS and the Science Alliance held a conference as part of National Science Week on the issue of "*Science and Race*" on 22 March 2000. The report is available from IPMS;

3. *The Rising Tide: A Report on Women in Science, Engineering and Technology* (HMSO, ISBN 0 11 4300968, 1994);

4. *Gender and SET*—Jane Fielding and Judith Glover (Findings from ESRC research project, 1994–96, reported to Science Alliance Seminar. "A Fair Deal for Women in SET 1998);

5. Quoted from a report in the *Times Higher Education Supplement* 22/29 December 2000 p.3

6. IPMS comments on the Government's Implementation Plan for the CST Recommendations in the Report. *Scientific Activity Across Government* IPMS 4 December 2000.

7. *Immigration rules eased to counter skill shortage* in Financial Times 18 December 2000.

8. Council for Science and Technology *Review of S&T Activity across Government*: HMSO July 1999

9. The Royal Society *Developing a National Strategy for Science* July 2000;

10. IPMS Conference on Scientists and Scientific Advice on Government Policy Making in October 1999. The report *Oracles or Scapegoats* is available from IPMS. IPMS with its colleague unions in the Science Alliance also held a seminar on "Is Whistleblowing in Science Really Necessary?" on 8 September 2000 as part of the BA Science Festival. A report of that event is also available from IPMS.

11. IPMS Submission to Patent Office Consultation on *Intellectual Property in Government Research Contracts: Guidelines for Public Sector Purchases of Research and Research Providers*. October 2000. Paragraph 1, p.3

12. Response by IPMS to "Creating Knowledge, Creating Wealth: Report by John Baker into Realising the Economic Potential of Public Sector Research Establishments". October 1999.

13. *What Future R&D? IPMS Bulletin* November 1999

14. IPMS response to OST consultation on a Code of Practice for Scientific Advisory Committees November 2000.

Annex A

IPMS Analysis of Development Based on "SET Statistics 2000" and "Science Budget 2000"

1. The allocation of the Science Budget for 2001–02 to 2003–04 was announced on 22 November. The first part of this note set out the new allocations and analyses the implications for research in IPMS membership areas. The second part of the note provides some analysis of "SET Statistics 2000", also published in November. There is no Forward Look for 2000, so for SET expenditure outside the scope of the Science Budget analysis is necessarily retrospective.

SCIENCE BUDGET 2001–02 TO 2003–04

2. The Science Budget sets out the detailed allocation of the additional £725 million over the three years covered by the 2000 Spending Review (SR2000). As set out in the Science White Paper "Excellence and Opportunity" this comprises:

- £356 million for scientific research, of which 70 per cent is accounted for by cross-research council programmes in genomics, e-science and basic technology (see paragraph 5).
- £1 billion for investment in the infrastructure of the science and engineering base, part funded by the Wellcome Trust.
- A £140 million Higher Education Innovation Fund
- An increase in PhD student stipends from £6,800 in the current academic year to £9,000 in 2003–04.

- — A programme of up to £4 million a year, jointly funded by the Wolfson Foundation and Royal Society, to assist the recruitment of up to 50 top researchers.

3. Table 1 sets out the Science Budget allocation in cash terms. It also shows the percentage increase in component parts of the Budget over the three year period. Figures for 2001–02 are not directly comparable with those previously published because of a change in accounting convention to Resource Accounting and Budgeting.

4. It is interesting to note that:

- — Of the £1 billion allocation for infrastructure investment must £100 million—amounting to 10 per cent of the total funding— is allocated for modernisation of research council institutes and the development of large national science facilities (in 2002–03 and 2003–04). The remaining 90 per cent of the fund will be used for investment in universities.
- — For infrastructure investment beyond this period, the Science Budget states that OST is developing a rolling ten year road-map for future large infrastructure projects taking into account developments in Europe and worldwide. The first version of this road-map will be completed this month and the Government intends to announce in January 2001 preliminary funding for projects to start development in the period 2001–02 to 2003–04. It is not clear whether the £68 million for capital expenditure yet to be allocated is for this purpose.
- — There is a £20 million allocation for DIAMOND in each of the next three years. The Science Budget states that since the decision to allocate DIAMOND at the Rutherford Appleton Laboratory was taken in March 2000" . . . planning for the project has been moving ahead rapidly. Management structures for the initial phase of the project are in place, supported by scientific and technical advisory committees, comprising both UK and international experts to advise on the detailed specification and design for DIAMOND. The project is now in a position to appoint key senior personnel and is setting up a search committee to identify both a Technical Director and Chief Executive for the DIAMOND Joint Venture Company . . . With the headline specification agreed, the detailed design activity is about to start, involving the secondment of key UK design expertise from CCLRC at Daresbury to the DIAMOND project team".

Table 1

ALLOCATION OF SCIENCE BUDGET 2001–02 TO 2003–04

£ million	*2001–02*	*2002–03*	*2003–04*	*% change to 2001–02 to 2003–04*
MRC	349.614	371.930	387.151	+10.7
BBSRC	213.987	232.603	250.151	+16.9
NERC	192.865	205.414	216.750	+12.4
EPSRC	436.202	461.540	489.911	+12.3
PPARC	206.289	220.383	232.208	+12.6
ESRC	74.447	82.763	91.533	+23.0
CCLRC	7.421	8.113	9.952	+34.1
Research Councils' Pensions Schemes	26.970	28.450	29.740	+10.3
Royal Society	25.945	28.745	29.245	+12.7
Royal Academy of Engineering	4.270	4.770	5.270	+23.4
DIAMOND	20.000	20.000	20.000	
Joint Infrastructure Fund	125.000	—	—	
Science Research Investment Fund	—	125.000	250.000	
Joint Research Equipment Initiative	10.000	10.000	10.000	
Capital (not yet allocated)	—	34.000	34.000	
Higher Education Innovation Fund	20.000	20.000	40.000	
University Challenge	—	5.000	—	
Science Enterprise Challenge	—	5.000	10.000	
Exploitation of Discoveries at PSRES	10.000	—	—	
Cambridge MIT Institute	14.000	14.000	14.000	
Foresight Challenge	—	3.000	5.000	
OST Initiatives	3.000	3.100	3.350	+11.7
OST Admin Costs	11.192	11.192	11.192	0
Exchange Rate and Contingency Reserve	15.264	15.464	16.014	+4.9
TOTAL	1,766.467	1,910,467	2,155.467	+22.0

Source: Budget 2001–02 to 2003–04.

- There is a £10 million allocation for exploitation of discoveries at PSREs in 2001-02, presumably in support of measures proposed in the Baker Report, but no funding allocation for later years. The Science Budget states only that "details of the operation of this fund are currently being developed."

Cross-Council Research Programmes

5. As indicated above, there are three cross-council programmes: in genomics, e-science and basic technology. These have a total budget allocation of £252 million over the three years to 2003–04, of which £240 million is resource and £12 million capital. This breaks down as follows:

- £110 million for genomics, almost half of which is allocated to the MRC. BBSRC will get £33 million, NERC £6 million and EPSRC £13 million.
- £98 million for e-science, of which £41m is allocated to EPSRC for high performance computing, its core-science programme and applications in physical and engineering sciences. The next largest beneficiary is PPARC, which will receive £26m for applications in astronomy and particle physics—in particular the computing for the Large Hadron Collider at CERN, BBSRC will get £8 million, NERC £7 million, and CCLRC £5 million. The Science Budget states that "The Councils will set specific targets for the use of Basic Technology funds in agreement with OST, and will report annually on progress towards these targets. Councils may also receive some funds from other DTI budgets, and will have to agree targets for this additional money and account for this annually to the Department. In addition, EPSRC will receive ring-fenced resources for the core programme on behalf of all the Councils".
- £44 million for basic technology, £41 million of which will be held by EPSRC on behalf of all the research councils. Expenditure of this money will be supervised by a Basic Technology Panel covering the interests of all research councils, but with operational management undertaken by EPSRC.

Allocations to the Research Councils

6. Table 2 shows that the effects of SR2000 additions to baseline spending will mainly take effect from 2002. Increases in BBSRC, NERC, EPSRC and PPARC budgets for 2001–02 are all below the rate of inflation.

Table 2

SR2000 ADDITIONS TO BASELINE SPENDING (PER CENT CHANGES)

Research Council	*2001–02 per cent*	*2002–03 per cent*	*2003–04 per cent*
BBSRC	1.97	10.83	19.2
NERC	0.5	7.04	12.95
EPSRC	2.58	8.54	15.2
PPARC	1.37	8.29	14.1
CCLRC	15.3	26.1	54.6

Source: Science Budget 2001–02 to 2003–04.

7. In relation to the specific allocations, the Science Budget states that:

BBSRC—Areas of strategic importance include spongiform encephalopathies and genomics research. BBSRC objectives include ensuring that the wider life science community benefits from co-ordinated genomics facilities established by BBSRC and enhancing the strategic development of the bioscience base. There is a capital allocation of £5 million in 2002–03 and 2003–04 for "new and upgraded laboratories and facilities in its Institutes".

NERC—"NERC is developing a five to ten year vision, which includes making its Research Centres fit for purpose and more focused in their delivery of long-term core science in priority areas. This requires reassessing the ratio of the Science Budget to external funding, reducing capital liabilities and infrastructure costs, and facilitating strategic partnerships with other bodies". In fact there is a small decrease (£0.03m) in the funding allocation for NERC programmes and PhD stipends in 2001–02 and among its objectives are "further progress on the rationalisation and restructuring programme to improve scientific capability and collaboration whilst reducing Council's liabilities, by the end of 2003". Three new priorities for research are identified: rapid climate change in NW Europe; virtual centre for atmospheric sciences; and sustainable technology". Like BBSRC, NERC will receive £5 million in 2002–03 and 2003–04 to invest in buildings and equipment for its research centres.

EPSRC—Most of the increase in the EPSRC budget is to fund its contribution to the cross-council research programmes. It will be expected to manage the e-science and basic technology programmes on behalf of all the research councils. The work on e-science will be supported by £9 million of capital investment. Other objectives include encouraging scientists and engineers from a range of disciplines to address problems in life sciences and promoting collaboration between physical and life sciences.

PPARC—PPARC is expected to pay the UK subscription to CERN and a large part of the subscription to the European Space Agency. It will also negotiate entry to the European Southern Observatory but this will require "major savings" from PPARC's current budget. Thus there is a planned decrease in expenditure in 2001–02 of £0.217 million and no provision at all for additional capital expenditure over the next three years.

CCLRC—The majority of additional funding for CCLRC is for the e-science cross-council programme. There is also provision for £1.2 million to fund projects to enhance existing facilities and to establish technology centres devoted to accelerator R&D and research into instrumentation. However, in 2001–02 there will be a decrease in planned expenditure on existing programmes of £0.015 million. The objectives set for CCLRC include assisting OST in the implementation phase of the Quinquennial Review.

8. SET Statistics 2000

9. Table 3 overleaf shows the trend in net government expenditure on SET in real terms since 1989–90. It confirms the major decline in departmental expenditure on SET over the last ten years. It also shows that there will be a real increase in expenditure next year but that for defence this will not be sustained for the following year.

Table 3

NET GOVERNMENT EXPENDITURE ON SET (REAL TERMS 1989–90 TO 2001–02)

£m	*Outturn 1989–90*	*Estimated outturn 1999–2000*	*CSR Plans 2000–01*	*CSR Plans 2001–02*	*% Change 1989–90 to 1999–2000*	*% Change 1999–2000 to 2000–01*	*% Change 1999–2000 to 2001–02*
OST	n/a	144	162	179	—	+12.5	+10.5
Research Councils	1,115.8	1,302	1,331	1,333	+16.7	+2.2	+0.2
Total Science Vote	2,268.3	2,577	2,675	2,736	+13.6	+3.8	+2.3
Civil Departments	1,671.5	1,450	1,475	1,521	−13.3	+1.7	+3.1
Civil Departments (exc NHS)	1,671.5	1,056	1,091	1,146	−36.8	+3.3	+5.0
Defence	2,972.2	2,035	2,307	2,250	−31.5	+13.3	−2.5
Total Depts	4,643.7	3,485	3,782	3,771	−25.0	+8.5	−0.3
Total Depts (exc NHS)	4,643.7	3,091	3,398	3,396	−33.4	+9.9	−0.1
Indicative Contribution to EU	238.9	351	368	345	+46.9	+4.8	−6.3
Grand Total Real Terms	7.151.0	6,413	6,824	6,851	−10.3	+6.4	+0.4
Grand Total Real Terms (exc NHS)	7,151.0	6,019	6,440	6,476	−15.8	+7.0	+0.6
Grand Total (cash terms)	5,148.4	6,155	7,152	7,360	+19.6	+16.2	+2.9

Source: SET Statistics 2000 Tables 2.2 and 2.1

Notes:

1. SET is defined as research and experimental development, technology transfer, scientific and technical postgraduate education and training.
2. OST figures exclude departmental running costs.
3. The SET programme for the NHS Executive was included in the total for Civil Service departments for the first time in 1995–96.

GOVERNMENT R&D

9. The Frascati Manual divides R&D into three related activities; basic research, applied research and experimental development. Table 4 shows that civil R&D budgets fared slightly better than those for SET over the past 10 years and will continue to do so. However within MoD there is a clear emphasis on development, on which there is a planned increase in expenditure of 21.8 per cent between 1999–2000 and 2001–02. Research expenditure over this period will fall by 16.6 per cent.

Table 4

COMPARISONS OF CHANGES IN SET WITH R&D EXPENDITURE (% CHANGES)

	1989–90 to 1999–2000		*1999–2000 to 2001–02*	
	SET	*R&D*	*SET*	*R&D*
Civil Depts	−13.3	−8.8	+3.1	+5.6
Civil Depts (exc NHS)	−36.8	−36.2	+5.0	+9.2
Defence	−31.5	−31.5	−2.5	+10.5
Total Depts	−25.0	−24.1	−0.3	+8.6
Total Depts (exc NHS)	−33.4	−33.1	−0.1	+9.4

Source: SET Statistics 2000 Tables 2.2 and 3.2.

10. In key departments, both SET and R&D have fallen as a proportion of total departmental spending as shown below.

Table 5

SHARE OF DEPARTMENTAL SPENDING ON SET AND R&D (%)

	1988–89		*1998–99*	
	SET	*R&D*	*SET*	*R&D*
MAFF	3.2	2.6	2.4	2.4
DTI	7.1	5.3	5.6	4.1
MoD	41.9	43.7	35.6	36.7

Source: SET Statistics 2000 Tables 2.5 and 3.3.

PURPOSE OF SET EXPENDITURE

11. Table 6 sets out the purpose of R&D expenditure in key departments and research councils. It shows that in HSC and departments where a high proportion of research is devoted to policy support, like MAFF and DETR, there is likely to be very limited scope for commercialisation of research output.

Table 6

R&D EXPENDITURE BY PRIMARY PURPOSE (1998–99 OUTTURN, % OF TOTAL)

	General Support	*Government Services*	*Policy Support*	*Technology Support*
OST	100	0	0	0
BBSRC	96.3	0	0	3.7
NERC	88.6	0.7	8.3	2.5
EPSRC	89.9	0	0	10.1
PPARC	94.9	0	0	5.1
MAFF	8.3	0.07	70.3	21.4
DETR	0.2	10.2	66.8	22.9
DH (exc NHS)	0.2	48.6	48.9	2.3
HSC	0	0	100	0
Home Office	1.4	92.4	6.6	0
DTI	0	0	48.0	52.0
Scottish Exec	6.6	19.8	32.6	41.1
Welsh Assembly	0	86.7	12.8	0

Source: SET Statistics 2000 Table 3.6.

Notes:

1. General support = all basic and applied R&D.
2. Government services = R&D relevant to any aspect of government service provision (all defence included here).
3. Policy support = R&D which government funds to inform policy (excluding government services and technology support) and for monitoring developments of significance to the welfare of the population.
4. Technology support = applied R&D that advances technology underpinning the UK economy (excluding defence). The category includes strategic as well as applied research and pre-competitive research, under schemes such as LINK.

FUNDING SOURCES

12. Table 7 shows the UK's heavy dependence on government to fund defence R&D.

Table 7

UK GROSS EXPENDITURE ON R&D PERFORMED IN THE UK
(1998, % SHARES OF FUNDING)

	Total	*Civil*	*Defence*
Government Departments	16.8	8.6	63.4
Research Councils	7.3	8.5	0
Higher Education Funding Councils	7.0	8.2	0
Higher education institutions	0.8	1.0	0
Business enterprise	47.3	52.3	19.1
Private non-profit	4.0	4.7	0
Abroad	16.8	16.7	17.5

Source: SET Statistics 2000 Table 6.1.

INTERNATIONAL COMPARISONS

13. Table 8 shows the UK lagging behind international competitors both in terms of government investment in R&D and business investment in R&D as a share of GDP. The comparisons are for 1998, which are the lastest figures available. However, these pre-date the effects of the Comprehensive Spending Review.

Table 8

INTERNATIONAL COMPARISONS OF R&D EXPENDITURE
(1998, % OF GDP)

	Government (GERD)	*Business (BERD)*
UK	1.82	1.19
Germany	2.32	1.57
France	2.20	1.37
Italy	1.03	0.56
Canada	2.89	2.10
Japan (1997)	1.61	1.03
USA	2.77	2.08

Source: SET Statistics 2000 Figure 7.2.

EMPLOYMENT IN R&D

14. There has been a significant decline in the total number of staff employed in Government R&D over the last 10 years, as shown in Table 9. This shows the effect of privatisations over the period in depleting the government scientific resource.

Table 9

PERSONNEL ENGAGED ON R&D IN GOVERNMENT DEPARTMENTS

	1988–89	*1998–99*	*% Change*
Research Councils	12,970	11,117	−14.3
MAFF	2,201	1,875	−14.8
DETR	1,505	223	−85.2
HSC	113	123	+8.8
Home Office	244	388	+59.0
DTI	1,003	126	−87.4
Scottish Executive	453	1,670	+268.7
Welsh Assembly	10	2	−80.0
Total Civil Departments	8,232	6,237	−24.2
MoD	16,206	11,843	−26.9

Source: SET Statistics 2000 Table 8.4.

Note: Scottish Executive figures include staff at SARIs, SAC and SNH from 1992–93.

15. Looking more specifically at employment by function, Table 10 shows that the decline in numbers of researchers employed by research councils has been offset by growth in the number of technicians employed. The increase in research staff employed by MoD is due to a steep upward shift in 1998–99 following a period of long term decline. In 1997–98 MoD employed 4,940 researchers, 1,499 technicians, and 2,067 other support staff and administrators. Across all areas there has been a substantial cut in support staff.

Table 10

PERSONNEL ENGAGED ON R&D IN GOVERNMENT BY FUNCTION

	1988–89	*1998–99*	*% Change*
Research Councils			
Researchers	6,127	5,245	−14.4
Technicians	1,589	2,571	+61.8
Others	5,254	3,301	−37.2
TOTAL	12,970	11,117	−14.3
Civil Depts			
Researchers	3,683	2,498	−32.2
Technicians	1,449	1,451	+0.1
Others	3,100	2,288	−26.2
TOTAL	8,232	6,237	−24.2
MoD			
Researchers	5,209	6,625	+27.2
Technicians	2,809	2,654	−5.5
Others	8,188	2,564	−68.7
TOTAL	16,206	11,843	−26.9

Source: SET Statistics 2000 Table 8.5.

APPENDIX 67

Memorandum submitted by GlaxoSmithKline

I am responding as Chairman of GlaxoSmithKline, the newly merged corporation comprising Glaxo Wellcome and SmithKline Beecham. As you will recall both companies submitted evidence back in June last year. The following comments build upon those submissions.

First I would stress that GlaxoSmithKline welcomes the White Paper as a significant and positive step in the science and innovation agenda in the UK. The Paper contains many sensible suggestions, building on developments since the 1993 White Paper carried through successive Governments. Particular points of note include:

- The emphasis on the importance of scientific excellence as the main criterion governing investment in basic science.
- The strategic understanding that universities must adopt a variety of missions in order to build on their individual strengths.

— The acceptance that Government must facilitate the translation of research advances into tangible national benefits, eg, in healthcare and that this requires continuing attention to build bridges between the public and private sectors. The call for action to harness the enormous impact and benefits of genetics research for future health by developing a strategy for service provision in the NHS is particularly welcome.

— The recognition that science and innovation need a stable and transparent framework of public support within which they can develop.

— The acknowledgement that, while the UK has a leading international reputation as a centre for science and innovation, there is no room for complacency.

— The introduction of a Small Business Research Initiative, inspired by the US example, opening up R&D procurement.

— The central understanding that growing scientific excellence is impossible without better science education in secondary schools.

— The importance of capitalising on the European and wider international dimensions in scientific research and collaboration and of encouraging the best people to come to the UK.

— The commitment to deregulating European markets and, in particular, speeding up product and patent approvals within the EU.

Overall the White Paper is to be warmly welcomed. There are however, a few areas where I believe careful consideration is needed as the work outlined is taken forward.

— First, the White Paper continues to enlarge the number of initiatives that support the positive exploitation of science and technology in the UK and creates a positive climate for innovation. All of these are justifiable in their own right, but there is no indication of which existing initiatives will be brought to an end or developed to address new objectives. This is always a difficult issue for governments, but a review of existing initiatives, their complementary roles and potential for development or cessation should be addressed in every White Paper.

— Second, the co-ordination of science and innovation policy across government is key. Too often positive strategies and investment by one government department, is undermined by another. The science and innovation strategies being developed across Whitehall, if effective, will provide a more coherent approach that should allow the UK to capitalise on its scientific and innovative capabilities across many sectors and have maximum impact on enhancing the quality of life for all in the UK.

— Third, GlaxoSmithKline applauds the intention signalled in the White Paper to encourage better IP management by universities and other publicly funded research institutions. We would however be most concerned if this were to result in the introduction of any Bayh-Dole" type legislation. As you may know, the Bayh-Dole Act was enacted in the USA in 1980 to encourage use of the patent system to promote the utilisation of inventions from federally supported research or development. In doing so, it provided a framework for the ownership and exploitation of intellectual property arising from government funded research in US universities, small businesses and non-profit organisations.

— The Act includes a number of worrying features all of which could serve as major disincentives to industry and academia collaboration if introduced into the UK. Key examples include the provision that the US government retains the right to take title to any invention made by a government employee and to ensure that inventions are properly exploited (so called "march-in" rights).

— US Universities may also elect to retain title to inventions arising from research funded in whole or in part by federal funds. This raises the possibility of US universities owning intellectual property generated using what is substantially company funding, perhaps because certain equipment used within the collaboration has been provided to the university by prior federal funding.

— Creating an environment to support exploitation and commercialisation of inventions arising from government funded research is clearly vital to sustaining the UK economy. Introducing into the UK legislation equivalent to Bayh-Dole however, would significantly undermine the flexibility and creativity that currently underpins industry and academia collaborations.

— Finally, as you may recall from SmithKline Beecham's initial submission to your enquiry, we welcome the Committee's support for extending the system of R&D credits to all companies (not just SMEs). The Chancellor's pre-Budget statement heralding an HMT initiative looking into incentives for vaccine development and announcing plans to consider extending to larger companies an existing scheme for small businesses under which they could offset their R&D against tax, suggests a shift in Government thinking on this issue. Enclosed therefore, is a short briefing paper on the R&D tax credits, emphasising the need for further discussion as part of the broader debate on science and innovation in the UK.*

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* Not printed.

Any support the Committee could led to promoting these concerns—while acknowledging the White Paper's many strengths—would be most welcome.

11 January 2001

APPENDIX 68

Memorandum submitted by Universities UK

1. Universities UK (our name changed from CVCP on 1 December 2000) is pleased to supply, as requested, a supplement to the memorandum we submitted in Summer 2000, reflecting the response of universities to Excellence and Opportunity: the Science and Innovation White Paper, and also related funding allocations.

2. The White Paper was warmly welcomed and enthusiastically supported by universities, building as it did on the earlier Competitiveness White Paper, which set a bold strategy for exploiting the UK knowledge base, particularly in our universities. The White Paper rightly identifies the central role of science and innovation in economic progress and improving quality of life. Equally rightly, it acknowledges the world-class quality of UK research, which has been sustained despite years of under-funding. That is a process that could not continue—it is good to see that progress has been made towards addressing the challenge. We also welcome the formal acknowledgement in the White Paper of the importance of the "dual support" system for funding university research, and also of the Government's key responsibility for funding basic research.

3. Universities have also welcomed the financial settlement for science and research, which accompanied the White Paper. The focus on new building, refurbishment and equipment will do much to redress a backlog that had grown up over many years and to which we had drawn special attention to this issue in our submissions to the Government. Indeed, in a number of respects the White Paper shows that the Government has listened carefully to the views expressed by universities. For example, the Government responded to submissions from universities about the mechanism for the allocation of the new funds, and has decided to adopt a formula-based allocation, based on quality and volume, rather than the costly and burdensome bidding process employed for the previous system, the Joint Infrastructure Fund. It was recently announced that the requirement for universities to provide 25 per cent of SRIF awards from their own or third party resources would be waived in the case of collaborative proposals; we regard this as a welcome incentive for inter-institutional co-operation. The early stages of the Transparency Review already indicate that public funding for research is allocated for the purpose for which it was given, and indeed that it is under-written from other sources. The task now is to ensure that government support for research is at least sustained at this level.

4. Generally, the White Paper is well-focused and the resources that accompany it will give a much needed boost to universities to help them play their part in realising the objectives identified. It should also feed through beneficially to the economy in due course. We would argue that in some cases it does not go far enough to tackle the problems it identifies.

Supply of Graduates

5. The White Paper correctly identifies the current excellence of UK science education. It acknowledges a decline in graduate numbers in some science subjects, but it borders on complacency about the recent decline in demand from UK students for places in these subjects. For many years talented overseas students have been attracted to UK science and technology courses but this supply is threatened by increased availability of good quality undergraduate and postgraduate courses in their countries of origin as well as the entry of other suppliers of education into the market. The presence of overseas students has to some extent been masking the decline of the UK student intake to science and engineering in recent years.

6. The moves to attract science graduates to teaching are welcome, although in the current climate, their success could exacerbate the problem of graduate supply to business. The real answer must be to increase significantly the undergraduate intake to science and technology. It is possible that pupils' disenchantment with science begins as a result of being taught at early stages by non-specialist teachers. There is much to be done to make the curriculum relevant and attractive at the secondary level. The "Young Ambassador" and "Young Foresight" programmes are welcome, but they may need increased resource to be effective.

Retaining the Research Base

7. The White Paper also identifies a supply problem at the postgraduate level, where shortages of graduates and market forces tempt the best graduates into industry rather than research. This trend poses a long-term threat to the quality of R&D in both industry and universities. The proposal to increase stipends for research assistants is welcome: the question will be whether it goes far enough fast enough and whether it takes sufficient note of market trends in particular subject areas.

8. New funds to attract leading researchers to the UK are also welcome, but to be effective they will need to be accompanied by resources for postgraduate and post-doctoral support, as well as the continuing problem of overall salary levels in HE. Career prospects for post-doctoral researchers are a significant issue. Only a small minority can aspire to securing a permanent position in universities and so an early introduction to the world of industry and business is in their long-term interest. The Research Careers Initiative remains the main vehicle for progress at a national level and deserves support. It is only through a genuine partnership between industry, universities and government that these challenges can be met.

9. Companies increasingly seek to recruit graduates and postgraduates who are able and prepared to be involved in a broad range of company business, but they look to outsource their R&D to universities, for financial reasons and because of the speed of technological change. Science and engineering graduates will thus need to be both well versed in their specialisation but also entrepreneurial and flexible. Researchers will also need to be able to support fundamental research but also to offer high quality flexible research programmes to meet industrial needs. They will work in university-based research centres alongside industrially-sponsored groups, perhaps sharing facilities jointly funded by research councils and industry. The development of such a model—in which all parties agree on transparent resource allocation—could provide a tremendous boost to the UK economy; the alternative is that UK industry will turn to overseas centres for its R&D.

University-Industry Interaction

10. We welcome the support announced in the White Paper for knowledge transfer and research commercialisation. Indeed the list of support schemes grows increasingly long and complex, and we hope that the new HE Innovation Fund, announced in the White Paper, will in time provide the opportunity to make knowledge transfer funding higher profile, more streamlined and less bureaucratic. The White Paper contains many separate and distinct initiatives, which need to be developed strategically into a common view and plan of action between government, business and universities. We are concerned lest a situation persist in which universities, suffering from initiative fatigue, focus on funding that suits them and their internal plans, and companies find it too difficult and wearisome to navigate their way through potential opportunities. A truly joined-up approach is something we are still seeking.

11. Certainly we applaud the intention behind HEIF that it grow and become a permanent funding stream for knowledge transfer. Universities enthusiastically embrace the notion of "reach-out" or knowledge transfer to stimulate local and national economy, as a "third mission" alongside teaching and research. We trust that HEIF will evolve into a formula-driven rather than a bidding-driven scheme, based on flexible, generic objectives and measurable contributions to the economy. Universities will contribute more effectively to this goal if allowed the freedom to develop their own approaches rather than responding to a narrow and prescriptive set of criteria.

12. We commend the recognition in the White Paper and related spending decisions that universities are central to the growth and success of the knowledge-based economy. We believe that the survey of university-industry interaction, announced in the White Paper, will provide evidence to debunk the myth that UK universities are good at research but poor at exploiting it for the public good. Nevertheless we can all benefit from sharing good practice. That is why Universities UK is shortly to publish a guide to the management of university consultancy. And we will also work with government, as invited in the White Paper, to disseminate good practice in the effective management of intellectual property.

13. Many universities enjoy excellent relations with large businesses where their interests coincide, often to do with high level R&D and/or consultancy, although it can also be on the basis of work placements and the supply of skilled graduates for employment. These relationships have proved in many cases to be fruitful, but they need to be put on a more open, transparent, full-cost basis. Less common, but often achieving a higher profile, are relationships across a spectrum of large to medium sized firms in a particular sector (eg the motor industry or chemical engineering).

14. A more difficult relationship, but one which all are agreed is a key to our future economic success is the relationship between a university and one, or a cluster of, SMEs, especially in high-tech areas, which the White Paper identifies as central to future prosperity. The relationship is not an easy one for either side and we need help to make it work. The White Paper offers a number of potential solutions, and additional funding for interaction will certainly help universities build capacity for co-operation with business. However, we are less sure about stimuli on the demand side; we need to raise the low level of R&D investment in UK industry (recent figures are promising, and the Chancellor's pre-budget statement raised prospects of further incentives, but there is more to do). We also need a financial driver for SMEs who are often under such day to day pressure that the promise of jam tomorrow (ie future profit) is not compelling, and where there is cynicism about the usefulness and bureaucracy of Government intermediary bodies. RDAs may be able to contribute here, by focusing their resources on such things as cluster formation, incubators and business clubs. Until that happens, the UK will suffer from what a CVCP study this year called "a lack of absorptive capacity" to make the best use of the outputs of universities.

15. The commitment to further rounds of incentives to boost seed corn funds and entrepreneurialism in universities is also welcome. By spinning out their own companies, universities will obviously contribute more

to economic development and begin by example to build stronger relationships with high growth SMEs. The Small Business Research Initiative proposal should also boost connections between SMEs and universities, if it allows universities to be involved with SMEs in the procurement process. This is the type of win-win situation where there are clear incentives for all players and which will lead to further co-operation in due course as the partners develop mutual trust.

OTHER ISSUES

16. The White Paper's emphasis on science and technology can overshadow the part to be played in innovation by other disciplines. The White Paper appears to regard knowledge and innovation, and the contribution that they can make to the economy and the quality of life, as solely to do with science and technology. But many of the new ideas in the knowledge economy, including innovation in the increasingly important creative industry sector, will come from research in other disciplines, including the arts and humanities. That is one argument for the establishment of an Arts and Humanities Research Council. We also need the insights and training offered in the social sciences and in business and management. Nor is it only research with evident commercial potential that is to be valued—universities are where fundamental long-term work takes place.

17. Our major concern, however, is with the wider funding needs of HE. There remain major teaching infrastructure needs and resources to enable universities across the board to recruit and retain high quality staff. The White Paper includes welcome measures to improve recruitment, but much more will be needed to attract the staff we need to work in our laboratories and supervise the research students who will be attracted by rises in PhD stipends. The needs of those universities—unlikely to be major recipients of research infrastructure funding, but who make an important contribution to the national research effort, not least by the teaching of graduates with research potential in key students—are also highly relevant.

18. We are aware of the science budget allocations to the research councils, but note that the details of the methods for allocating SRIF, UC, SEC and HEIF funds have still not been announced.

11 January 2000

APPENDIX 69

Supplementary memorandum submitted by the Engineering and Physical Sciences Research Council

Following our earlier correspondence, I am writing to offer brief comment in connection with your review. As I indicated at that stage, the EPSRC is a directly interested party and I hope that as a consequence, you will excuse us from making a lengthy response. There are however, two points where the experience of the EPSRC may be of value to the Committee, since these points arise from experience with the inner workings of the systems set in place in 1993–94.

The first relates to the structure for the senior management within the newly organised research councils. Here I would wish to emphasise that the experience of the EPSRC has confirmed the value of the arrangements proposed in the White Paper. The combination of a part-time industrial Chairman and a full time academic Chief Executive has been found to be most helpful. The strategic directives imparted by an industrial Chairman can be of the greatest value; they have been particularly useful as the EPSRC has established its patterns of operation during the first years of its existence.

A second issue relates to the structure of six research councils, which resulted from the White Paper. This has been found to be successful in allowing specific missions to be identified and organisational structures developed to fulfil them. Thus, major international collaborations can receive concentrated attention in the programmes for particle physics astronomy and space science (PPARC); underpinning conventional scale science in the university sector can receive concentrated attention (eg EPSRC). As with any structure which seeks to identify divisions within the fabric of science and engineering, there have been interface issues, but the individual councils working with the Director General of the Research Councils have given specific attention to managing such interfaces. Notable examples of initiatives of this kind are the Tyndall Centre for Climate Change Research (jointly funded by NERC, EPSRC and ESRC) and the Interdisciplinary Research Centre for Tissue Engineering (jointly funded by EPSRC, MRC and BBSRC).

12 January 2001

APPENDIX 70

Supplementary memorandum submitted by the Institute of Physics

The Institute of Physics is a leading international professional body and learned society with over 30,000 members, which promotes the advancement and dissemination of a knowledge of, and education in, the science of physics, pure and applied.

The Institute is pleased to have the opportunity to add to its earlier comments to the Select Committee for its inquiry into the DTI's White Papers of 1993 and July 2000.

The Institute welcomes the 2000 White Paper, as an important contribution to public policy. The Institute also welcomes the associated Science Budget settlement, which together with the earlier 1998 Comprehensive Spending Review provides a firm basis for the necessary sustained growth of the UK's scientific research. Government is to be congratulated for taking practical steps towards providing the UK with appropriate levels of research investment. However, despite, these welcome measures, it will be difficult to rectify the UK's long-standing R&D shortfall relative to its key international competitors, particularly because research budgets around the world have been increasing significantly. For instance, last year US federally funded research budget grew by 9.1 per cent in a single year.[14]

The White Paper considers an important set of developments affecting the research culture of the physical sciences, including globalisation, the knowledge economy, the internet revolution, multidisciplinary research frontiers and changes in the social contract. Two particular issues stand out.

First, key changes to the nature of scientific research will occur largely independent of the actions of government. Government has a responsibility to respond to change, to help shape change in the science and technology arena, and to provide resources for specific elements but it must work in partnership with other key stakeholders to ensure maximum effect. The White Paper has identified several emerging threats and opportunities facing the UK's technological future. The challenge lies in delivering sound policy in such a shifting landscape.

Second, the changes now underway in the physical science are unusually fast moving. The Institute notes extraordinary demand for highly qualified physicists from emerging high-technology sectors, such as telecommunications, IT, management consultancy, banking and the entertainment industry. The high remuneration packages on offer to physicists entering such sectors mean other sectors, including health care, defence research, university research and school teaching, are struggling to find sufficient physics applicants to fill positions. The pool of applicants is limited and the salaries and terms of employment on offer in these other sectors appear increasingly uncompetitive. Several of the struggling sectors are publicly funded, not least academic and research sectors, which are finding it difficult to respond to these emerging pressures.

Government stills plays a dominant role in the supply of scientific personnel and a large role in demand. Considering the public sectors' demand for scientists there are key areas of the public sector that are already facing difficulties in recruitment. Urgent action is required by government to make scientific careers in the public sector more attractive.

The Institute would like to make the following points in response to specific statements made in the White Paper.

1. The Institute welcomes the £1 billion Science Research Investment Fund (chapter 1, paragraph 32) and the £250 million boost to research in key areas of physics (including nanotechnology and quantum computing) and biology, which will help UK universities to compete on an international level. The Institute is also pleased with the commitment by the government, the Wolfson Foundation and the Royal Society to contribute £4 million a year to recruit top researchers (paragraph10) and that postgraduate students will benefit from increased financial support.

2. The Institute also welcomes the additional funds for universities through the Higher Education Innovation Fund (chapter 3, paragraph 9). Some of the developments facing UK physics research, such as an increasing emphasis on "third leg" mission will require effort and flexibility on the part of the research community. The increasing diversity of missions for our universities represents an opportunity for the sciences. The Institute would be glad to play a role in providing a forum for the research community and policy-makers to take these ideas forward.

3. The Institute is of the view that science in general, but physics in particular, has not been funded at a level that will retain our position against the enormous strides taken by other countries and industrial competitors. Science funding has failed to exploit the imagination, skills and historical lead of the British scientific community, both at the detail (eg effective funding of decent laboratories and workshops) and at high level (eg full-scale shifts of funding away from exciting and relevant areas of research such as applied nuclear physics).

4. The infrastructure of the universities is fundamental if the UK is to maintain its stronghold as a world player in innovative research, and the additional money for infrastructure will certainly help in providing universities with better research facilities. However, more will be needed in the near future, if UK scientists and engineers are to compete effectively on a global scale. The Institute recognises the contribution of the

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[14] Science 291, (5501), p33, 5 January 2001.

Joint Infrastructure Fund (JIF), but does not agree that it has significantly affected university infrastructure. Rather, most of the money has been used to fund a number of important and worthy university based research and innovation projects. Although undoubtedly beneficial, JIF failed to address the essential problem of infrastructure. British university physics departments suffer from outdated machine shops, poor physical plant and buildings and eroded human resources in technical support. This view has been supported by an International Panel, which recently conducted a review of UK physics and astronomy research.[15] Given these limitations of JIF, the Institute is pleased to note that the £1 billion Science Research Investment Fund will provide funds in the region of £675 million to address the problems of inadequate research facilities in the universities. The Institute would be pleased to work with the Research Councils and the Office of Science and Technology (OST) to ensure that the new funds are used to the greatest effectiveness in physics research.

5. The White Paper makes several references to technologies in which physics is the key discipline, including modern communications, superconductivity, basic technology such as nanotechnology and the reference to CERN. To ensure the development of new knowledge and its utilisation for wealth creation, the UK needs to encourage physicists to follow their research instincts. Basic curiosity-driven research (chapter 1, paragraph 29) is vital to wealth creation and quality of life in the UK. Investment in fundamental research represents an underpinning for the multiple and complex demands of a high technology society.

6. The Institute welcomes the measures to stimulate investment by business and commerce in enterprise and innovation (chapter 3). In particular, further funding for the science enterprise centres is welcomed and proposed changes to the LINK initiatives will make collaborative work with business easier. The Small Business Research Initiative is an important proposal, but small business will need to be made aware of it and will need support to be effective at the bidding stage.

7. The Institute concurs with the view (chapter 2, paragraph 22) that the Research Assessment Exercise (RAE) may favour single subject research at the expense of interdisciplinary collaborations. Data prepared for the recent International Review of UK Physics suggested disturbing trends in research staff numbers in university physics departments, with an increase in the core physics disciplines and a decline in such areas as medical physics, biophysics, geophysics and atmospheric physics. These results, based on a limited data, warrant further investigation. The White Paper regularly points to multidisciplinary collaborations as vital to the future research capabilities of the UK and hence wealth creation and quality of life. The International Panel in its report was particularly critical of the punitive nature of the RAE and suggested that the continuation of the present system could result in substantially fewer research departments in physics, in the foreseeable future. It is debatable whether such a small number of departments would be sufficient to provide enough well trained PhDs for the academic and industrial needs of the UK.

8. The Institute has been an enthusiastic contributor to the Foresight initiative and welcomes the launch of the new Foresight Fund of £15 million (chapter 3, paragraph 3) which will aim to put the best ideas of Foresight 2000 in to action. However, the Institute also notes the statement that, in the past, the Government has not placed enough emphasis on basic technology (chapter 2, paragraph 29). The Institute believes that the Foresight fund should be used to fund those Foresight initiatives, which encompass basic technology. The science base is functioning well and should not be undermined by funding these new areas. Rather the Institute detects an opportunity to boost technology support expenditure through DTI budget lines that once supported an interventionist industrial policy.

9. The Institute welcomes the additional funding for PhD stipends, (chapter 1, paragraph 32) as current levels are deterring physics graduates from entering research careers. However, despite the additional funding, the Institute is of the view that serious attention must be paid to enhancing the career development of young physicists. The creation of long-term research positions in universities should be encouraged in order to avoid the current situation whereby many physicists are trapped in a series of successive short-term, low paid appointments. The Institute is, therefore, pleased that the Government recognises these concerns (chapter 2, paragraph 34). The Institute's report on the *Career Paths of Physics Post Doctoral Researchers*, raised concerns about the substantial minority of individuals taking up post doctoral research positions who go on to become career contract researchers. On 17 November 2000, the Institute held a forum to discuss the situation of physics post doctoral staff in light of the recommendations of the Research Careers Initiative Committee, the Institute's post doctoral report and the concerns regarding the career development prospects for young researchers featured in the White Paper. A report of this meeting is available. It was clear from the discussions in November that many of the policy concerns associated with contract research remain.

10. The Institute wholeheartedly concurs with the statement in the White Paper (chapter 1, paragraph 23), that the UK is involved in a global competition for talent and that world class scientific facilities are essential. Thus, the Institute notes with concern that reports that remuneration top-ups will only be available to a small fraction of the research community. The Institute applauds the steps taken to prevent the best researchers from leaving the UK, but urges that the money should be more widespread, as this will not be sufficient to prevent young qualified researchers seeking opportunities overseas.

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[15] *International Perceptions of UK Research in Physics and Astronomy*. Chaired by Professor Alexander M Bradshaw. Institute of Physics (2000).

11. The Institute is deeply concerned that the increasing numbers of talented physicists moving into newly emergent sectors are resulting in public sectors finding it increasingly difficult to recruit appropriate staff. The flow of highly qualified workers into emergent high technology sectors is a national strength and must be encouraged, but the shortage elsewhere requires short and long-term solutions and policy planning. In this context the Institute welcomes the Government's plans to attract more overseas scientists and engineers (chapter 2, paragraph 39) to the UK, but in the long-term a sustainable solution is needed that does not rely upon the recruitment of scientists trained at the expense of developing countries. Our national difficulties are severe and immediate. The US is responding to similar pressures. Not only will we be competing for the same pool, many of the talented individuals sought for the US are currently pursuing careers in the UK.

12. The Institute wholeheartedly agrees with the statement that Britain must enhance the excellence of its science base (chapter 2, paragraph 1) and as a direct consequence, needs better and more appealing science in its schools (chapter 2, paragraphs 4 and 5). At present far too many children moving to secondary school appear to lose interest in science. The number of women on undergraduate physics courses is only a quarter of the number of men. This is wasted potential and more must be done to encourage girls at a younger age to adopt an interest in the subject.

13. The Institute concurs totally with the statement (chapter 2, paragraph 11) that excellent teachers are the key to exciting science in schools, but that too many teachers do not have degrees in the subjects they teach. More needs to be done to attract the best physical science graduates into teaching. The Institute is deeply concerned about the decline in physicists entering teaching and is pleased with the White Paper's recognition of the problems of recruitment and retention of specialist teachers. There is a crisis in physics teacher supply, there are indications of yet a further drop in entrants to PGCE courses and the major impetus towards a solution to this crisis must come from Government. Extra funding is undoubtedly required, especially for mid-career salaries, but some other actions would be possible. The attached table outlines a strategy to encourage recruitment in the physical sciences. If the Committee has any questions concerning the measures proposed, please do not hesitate to contact the Institute.

14. The Institute agrees that public support and understanding (chapter 4, paragraph 31) are key components of the process of innovation. The relationship between science and society requires three communities—scientists, the Government and the wider public—to interact together on a basis of mutual understanding. Recent events such as BSE and GM foods have illustrated shortcomings in this interaction. Therefore, the Institute warmly welcomes the White Paper's reference to restoring public confidence in science (chapter 1, paragraph 37), by the Government implementing stronger guidelines from the Chief Scientific Adviser (CSA) on how scientific advice should be used in developing Government policy and by publishing a new code of practice for scientific advisers to Government; a consultation to which the Institute will forward its response in due course.

15. With regard to diversity of excellence in universities (chapter 3, paragraph 6) and the proposals on foundation degrees (chapter 3, paragraph 21), the Institute is conducting an in-depth inquiry into undergraduate physics, chaired by the Institute's President, Sir Peter Williams, which will cover these and other issues. The Inquiry is expected to report in the Summer of 2001.

16. The Institute welcomes the Government's intention to clarify CLRC's mission statement and funding arrangements (chapter 2, paragraph 18). The Institute recently expressed its concerns that the financing mechanisms operated by the CLRC were not an effective use of resources nor matched other research council's priorities. The Institute hopes that there will be a re-assessment of the funding base, and looks forward to hearing more of the outcomes following the recent quinquennial review, chaired by the current President of the Institute, Sir Peter Williams.

17. The Institute notes the view (chapter 3, paragraph 26), that there are significant differences between different regions, calling for different approaches. The Institute believes the recent North West Science Review has been a valuable exercise, given the difficulties faced by Daresbury Laboratory. It is the clearest example so far of explicitly regional considerations in DTI's science funding. However, if the Science Budget is to reflect regional considerations in future then an open policy debate should be conducted. The Institute remains committed to the principle of funding solely on the basis of "best science".

18. In response to the Scottish Science Strategy (chapter 3,) it should be noted that the Scottish Branch of the Institute is actively engaged in dialogue with the Scottish Executive. Similar advice is offered by the Welsh and Irish regional groupings to the regional assemblies and governments.

19. (Box page 26) The Institute has been an enthusiastic supporter of NESTA and welcomes the contributions it has made to science and physics in particular. The Institute trusts that NESTA will continue to increase its visibility and ambition.

20. In conclusion, the White Paper describes the complex innovation landscape of the UK and the future of the UK as a high-value-added economy. There is repeated and appropriate, emphasis on entrepreneurship and small businesses. Government must not lose sight of the needs of Britain's high-value-added major industries. Prominent in these areas are defence/aerospace and pharmaceuticals. There is much prominence given to underpinning Britain's research strengths in the life sciences. This is deserved. What is lacking is a visible concern for the needs of Britain's high-value-added large businesses founded in the physical sciences such as AEA Technology, UKAEA Fusion, Nortel Networks etc. The DTI maintain support for such vital sectors of the national economy.

If the Institute is able to assist the Committee further with its inquiry please do not hesitate to contact me.

15 January 2001

APPENDIX 71

Memorandum submitted by the Royal Astronomical Society

The Royal Astronomical Society covers both Astronomy and Geophysics and represents two linked communities. The Society's interests span a range including the solid earth, the solar system, stars, galaxies and cosmology. The RAS also publishes two leading journals, *Monthly Notices* and *Geophysical Journal International*, as well as *Astronomy & Geophysics*. The two grant awarding research councils with which the RAS is connected are PPARC and NERC.

Most of our interests are in basic (as opposed to strategic) research, without immediate applications to wealth creation. We regard it as extremely important that such research should be adequately supported, so that the UK can maintain its internationally competitive position in astronomy and geophysics. We were therefore extremely pleased by the enhanced funding announced in the recent Science Budget. We hope that this will allow research councils to protect their grant lines against inroads made by large projects. Maintaining a balance between small and large projects, and between experiments and theory, requires a carefully structured committee system.

We draw the Committee's attention to the recent review *International Perceptions of UK Research in Physics and Astronomy* which provides an external assessment of UK research in astronomy. This report lists many of the sub-fields of astrophysics and solar physics in which UK scientists are active and successful. The panel also made a careful assessment of the future decisions that must be made by the community of astrophysicists and solar physicists. These concerned, in particular, the need for international collaboration on the major new ground-based and space facilities that will be required to progress in these areas. The Royal Astronomical Society gave strong support to PPARC's bid for funding to allow the UK to join the European Southern Observatory and we welcomed the decision by OST to provide the additional funding that is needed. We are also pleased to see the emphasis on computation, through the GRID development, with plans for a "Virtual Observatory", as well as through provision of high-performance computing facilities.

The RAS, in collaboration with PPARC, has made a study of *Demographic Trends in Astronomy and Geophysics*. The number of astronomers in university posts has risen, owing to the creating of departments of physics and astronomy. We are, however, concerned to maintain the number and quality of university staff in these subjects. Academic careers are becoming less attractive in comparison with opportunities in financial services and computing, owing to low salaries and increases in external bureaucratic pressures. There is already a serious drop in the number of UK students starting on research in physical sciences. It is to be hoped that the recently announced increases in their stipends (which we welcome) will be in time to reverse this trend.

A major concern of the Society is the publication of its journals. At the moment they are very successful but it is clear that, as a result of electronic publishing, scientific journals will undergo major changes over the coming decade. Although the nature of these changes cannot yet be predicted, we are confident that there will still be a need to publish properly refereed papers in archival journals. It is to be hoped that the research councils will be prepared, if necessary, to assist learned societies in coping with the changes that lie ahead.

The Society is also active in promoting the public understanding of science and we strongly support efforts by OST and the research councils in this direction. The aim should be not only to improve public awareness of scientific issues, but also to promote the achievements of British scientists in the eyes of the world. Since the research councils are at the forefront of all big science in the UK, they are well placed to carry out this programme.

12 January 2001

APPENDIX 72

Supplementary memorandum submitted by the Particle Physics and Astronomy Research Council

EXECUTIVE SUMMARY

The Spending Review 2000 outcome was the best news for UK science for many years, but will only deliver its intended impact if increases in funding can be sustained over the long term.

The Government has recognised, through its Science Budget allocations, the power of fundamental physics to drive the IT (e-science) agenda, the importance of European collaboration and the economic value of advanced technology. This was far-sighted and will deliver important dividends over the medium to long term.

The increase in postgraduate student stipends is welcome but does not go far enough to enhance the status of careers in research.

The crisis in school physics teaching is a grave threat to physics research and to future prosperity and must be addressed, as a matter of urgency, across Government.

The 1993 White Paper

1. PPARC submitted a memorandum to the Committee on the impact of the 1993 White Paper in June 2000. Our general view then, which we re-assert now, was that overall the impact of that White Paper had been positive.

Funding for Science and Technology

2. The Government's Spending Review announced in July 2000 (and detailed in the Science Budget Allocations in November 2000) was the best news for UK science for many decades. If this can be sustained over the longer term it will help to bring UK spending more into line with its international competitors. More importantly it will underpin future economic and social progress.

University Research Infrastructure

3. Equally important was the continued commitment to university research infrastructure announced, with the support of the Wellcome Trust, in the Scientific Research Investment Fund (SRIF), to continue the start made by the Joint Infrastructure Fund. But the scientific community will need to work closely with university vice-chancellors to ensure that it is targeted at regenerating infrastructure in areas of highest scientific priority. Furthermore, investment in research infrastructure, through routes such as JIF or SRIF must be maintained over the long term if the research infrastructure is not to decay back to the appalling state it had reached before the JIF.

The 2000 White Paper

4. The 2000 Science and Innovation White Paper (Cm 4814) contained a number of useful measures to improve the economic exploitation of the UK science and technology base. The recognition of the economic importance of physics in the 21st century was welcome, if overdue.

Physics Teaching

5. The recruitment and retention of specialist science teachers (recognised in the White Paper) remains a critical issue. The entry to physics PGCE courses has fallen from 568 in 1993 to 205 by September 2000. The teaching of physics by generalist science teachers (mainly not graduate physicists) is unsatisfactory. School physics is the basis for many areas of economic and academic activity from academic astrophysical research to electronic engineering. There is a crisis in physics training. The OST commissioned report on "International Perceptions of UK Physics and Astronomy" is explicit in this respect:

> *"Attracting a diverse and highly qualified student population must start at the primary and secondary school levels. One of the most worrying statistics brought to the attention of the Panel is the recent drastic decline in the number of physicists entering post-graduate teacher training courses. This may reflect the poor salaries and increasing administrative loads in the teaching profession, in particular in state schools. If so, urgent action is required. The importance of maintaining the supply of young, enthusiastic and well-qualified teachers cannot be underestimated."

6. It is not clear whether all parts of government have sufficiently grasped the full significance of this. Recently announced incentives to teachers, and the DfEE Science Year—due to start this September are worthy, but unlikely to resolve the fundamental issues affecting specialist science teaching.

7. We suggest that the Committee might address, as a matter of urgency, the crisis facing specialist science teaching in the UK. If it is not addressed successfully by government, the new DTI/OST investments in science funding will not be able to yield their full return in future years. We note that the House of Lords S&T Committee are currently looking at science in schools. We will look with interest at its findings.

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* Extract from 3.3 of the International Perceptions of UK Research in Physics and Astronomy published by the Institute of Physics May 2000.

November Science Budget Allocations

8. The Science Budget allocations announced in November were unequivocally goods news for PPARC's research programmes, though PPARC still faces some hard choices.

9. Of particular importance to PPARC were:

(a) E-Science—the Government has recognised the role of modern fundamental physics (e-science) in driving the IT agenda, in particular computational grids, which will be driven by particle physicists, using the CERN Large Hadron Collider, and astronomers with access to increasingly powerful telescopes (ground and space based). Initially developed for research purposes, computational grid technologies will revolutionise the present world wide web as profoundly as the Web transformed the previous inefficient internet operating systems. The techniques developed will also find application in other scientific areas involving enormous quantities of data such as genomics, and environmental monitoring and climate change research. The Government has allocated £98 million over three years under this heading of which £26 million was allocated to PPARC.

(b) European Astronomy—the Government has recognised that, as in particle physics and space science, UK and European science will compete effectively in the world only if the UK is part of a strong European bloc. PPARC has received an additional £10 million per year to allow the UK to joint the European Southern Observatory (ESO). This will ensure that UK astronomers are actively involved in global scale preparations for the next generation of astronomy facilities, such as the Atacama Large Millimeter Array (ALMA) in Chile and the very large ($\approx$50m) optical/infrared telescopes now undergoing conceptual studies. In addition, ESO membership will give UK astronomers access to a suite of four world-class 8-meter ground-based telescopes, as well as other state-of-the art facilities. But it will also require PPARC to make some hard decisions in the coming months in rationalising its existing commitments to existing, older, ground based facilities.

(c) Student Stipends—the increase announced in postgraduate student stipends is welcome, but does not go far enough. PPARC has already agreed to speed up the rate of increase. Even then the country will still be seriously undervaluing some of its cleverest talent. Many high-quality students are prepared to work for less than an economic rate because of their interest and commitment to the subject. Increasing student indebtedness and attractive alternative graduate employment prospects also put the future supply of good physicists at risk. We would like to see postgraduate student stipends further increased to compete with other graduate options and to ensure that research is perceived as a worthwhile and rewarding professions, valued by society.

(d) Basic Technology and Faraday Partnerships—research in astronomy, space and particle physics has always depended on the development of new technology, ever since Galileo invented the telescope. Over the last century that technology has become increasingly complex and sophisticated and has generated applications from cancer treatment to drug design and satellite communications and control. To facilitate future collaboration with industry, PPARC recently led a review of its future needs for advanced technology and extended this, with the other research councils to cover all areas of research as part of the OST's Foresight Activity (copies enclosed)*. The Government's announcement of a cross-Council fund for basic technology (£44m over three years) is therefore welcome and timely.

PPARC expects its scientific community to benefit from this fund, and has been pleased to join the DTI Faraday Partnership Scheme, for which DTI has announced plans for further expansion. This will enable PPARC scientists and engineers to develop new technology more effectively in collaboration with UK industry and scientists in other disciplines. PPARC expects to fund one or two Faraday Partnerships in the coming year.

17 January 2001

APPENDIX 73

Supplementary memorandum submitted by the Medical Research Council

EXCELLENCE AND OPPORTUNITY

1. The Medical Research Council welcomed the science White Paper, and in particular the emphasis on delivering scientific "brain gain", whether through helping to attract the best scientists from abroad to work in the UK, or through encouraging a higher proportion of the best graduates to enter scientific research training, and ensuring the quality of that training.

2. At the time the new White Paper was published, MRC already had in place a fast-track research funding scheme to make it easier for universities and MRC units to bring researchers from other countries to the UK. Three senior university appointments in medial research have already been helped by use of the MRC scheme,

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* Not printed.

with up to a dozen more expected in the near future. We expect that universities will use the MRC scheme to complement the new funding for outstanding researchers announced in the White Paper.

3. MRC welcomed the provision of extra funding for postgraduate research stipends, which will bring the basic rate up to £9,000 in three years. At present, MRC pays considerably more (£7,450 outside London and £9,900 in London) than the basic research council rate, as we have long felt that, in a competitive and fast moving area with a strong industrial R&D sector, the basic rates were insufficient to attract high-calibre graduates. A recent consultation with UK universities suggests that even the new rates will not be seen as an attractive level of support in the biomedical sector, and MRC will continue to pay research students substantially more than the basic rate, and will decide on the new level of MRC stipends next month.

4. MRC considers that it is also timely to begin exploring alternatives to the established models of PhD (or MRes + PhD) support, and have recently launched a new pilot scheme for salaried pre-doctoral fellowships in MRC establishments. The first awards will be taken up in Autumn 2001, and graduates will be employed as salaried members of staff, with full contracts of employment and employment benefits, on fixed term contracts. The pilot will be carefully evaluated. We will be considering not only the effectiveness of awards in attracting highly talented individuals who might not otherwise have chosen a research career, but also the potential to improve perceptions of careers in scientific research by putting graduate research appointments on a par with other graduate career options.

PARTNERSHIPS

5. Our initial memorandum underlined how partnerships between research funders had become a pervasive feature of strategic planning since the 1993 White Paper.

As further examples, the past year has seen:

- the establishment of the Cancer Research Funders Forum, involving the Department of Health, MRC and the main charities. The Forum has already commissioned a review (By MRC) of prostate cancer research in the UK, and steps are already being taken to strengthen this underdeveloped area of research. The Forum has also helped pave the way for the new National Cancer Research Institute, which will play a similar co-ordinating role.
- the formation of a similar Funders Forum for Ageing Research which not only brings together the Department of Health and charities, but also BBSRC, ESRC and EPSRC, reflecting the contribution of research in the social science, in non-medical life sciences, and in engineering and IT, to the aim of extending quality of life.
- the allocation of funds in the Science Budget to three priority themes—genomics, e-science and basic technology—in which realising the UK's potential depends on ensuring there are well funded, effectively managed strategies co-ordinated across several, or all, research councils.

6. At an international level, MRC is also involved in an ambitious initiative planned by the EC, to address the three major diseases of poverty—AIDS, TB and malaria. The principal aim will be to bring new therapies quickly and efficiently through from basic research to clinical application, in large part through new public-private partnerships. MRC is liaising closely with the Commission on the preliminary planning, and given our research expertise in these areas, we anticipate playing a major role in the initiative.

SCIENCE BUDGET—INFRASTRUCTURE

7. A copy of MRCS's press release responding to the Science Budget announcement is attached*, and fuller plans for how MRC will use its funding and its links with other funders, to take forward priority areas and training will be published in March.

8. MRC welcomed the provision of a further £1 billion for capital infrastructure in UK universities and research council institutes. The Committee will be aware that further details of how the new capital funding for universities will be administered have been published since they heard evidence in October. These arrangements will, we believe, significantly reduce the administrative costs which universities and research councils had to occur in the JIF scheme. As responsibility for strategic direction is devolved to individual universities, the approach depends on a strong commitment to co-ordination among universities, and between universities and funders, to ensure the provision of space and equipment reflects realistic assumptions about future funding for research staff and programmes, and to avoid competition between universities leading to over-provision. MRC, along with other Research Councils is encouraging universities to consult informally on their plans at an early stage.

January 2001

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* Not printed.

APPENDIX 74

Supplementary memorandum submitted by the Economic and Social Research Council

There are a number of points we wish to make in addition to those in our June 2000 submission to the Committee's Inquiry.

1. The White Paper, *Excellence and Opportunity*, is mainly concerned with putting scientific knowledge into use through closer ties between the academic research community and the business sector. It explores a range of issues, from science education in schools to codes of practice for scientific committees, and it considers the role of government in the process of research and its exploitation. In its own terms, it may well have a positive effect on science and innovation.

2. However, one of our main concerns is that the social and economic sciences are almost completely absent from the White Paper, either as providing knowledge about the process of innovation, or as having a capacity for exploitation—particularly in an increasingly knowledge-based society and economy.

3. There is a great deal of work in the social sciences, much of it funded by the ESRC, covering business processes, innovation, economic and organisational performance. Many of the factors that promote or inhibit exploitation are behavioural, social and cultural, and forward projection of the trends and characteristics of the population in all areas of human activity form a key ingredient to business potential.

4. While the social sciences do not have such an obvious and commercially exploitable potential as the physical (or technical) sciences, they nevertheless are increasingly used in commercial processes—such as the design process for information and communication systems, and in the public service sector in the development and implementation of policies.

5. We noted in our previous submission to the Committee that the involvement of users of research in research council activity promoted by the Realising Our Potential White Paper had largely been achieved. However, we argued that this may have contributed to the diminishing public confidence in science and its exploitation, since it did not include the public from debates and decisions, and overtly addressed vested interests (mainly business) which may not be seen to be in keeping with those of the public.

6. The White Paper, *Excellence and Opportunity*, notes this problem, but does not address it adequately. The proposed Codes of Practice for Science Committees, for instance, fall well short of involving or serving the public community and its interests.

7. We remain less sanguine on the consistency between the Research Assessment Exercise 2001 and research utilisation than the White Paper.

8. Overall, therefore, we believe the Science and Innovation White Paper, though positive in many respects, unfortunately missed an opportunity through omitting social science research either as informing the mechanisms of innovation or as having potential for exploitation.

January 2001

APPENDIX 75

Supplementary memorandum submitted by the Royal Society of Edinburgh

INTRODUCTION

1. The Royal Society of Edinburgh (RSE) is pleased to respond to the Select Committee's request for comments on the new Science and Innovation White Paper, Excellence and Opportunity (Cm 4814) and the recently announced Science Budget. The RSE is Scotland's National Academy of Science and Letters, comprising Fellows elected on the basis of their distinction, from the full range of academic disciplines, and from industry, commerce and the professions. This response has been compiled by the General Secretary with the assistance of a wide cross section of Fellows.

SUMMARY

2. The RSE welcomes the strategic direction described in the White Paper and its emphasis on scientific excellence, the creation of the right climate for innovation, and the importance of high quality curiosity-driven research. The key points identified by the RSE include:

- The emphasis on having to gain public support for science and technology is particularly relevant at the present time with both science and engineering coming under the spotlight. (paragraph 5).
- In the key area of science policy, a good and close working relationship between ministers and officials at the UK level and in the devolved administrators is important. (paragraph 7).
- The RSE shares the concern about the appeal of science and engineering in schools, raised in the White Paper, and about the pay and conditions of school teachers and school laboratories. A recent

review of teacher's conditions of service (the McCrone Report) had lead to major pay proposals, to be funded by the Scottish Executive, and this should help with the recruitment of science teachers in Scotland. (paragraph 9).

- The £1 billion programme in partnership with the Wellcome Trust to renew the science infrastructure is of great importance. (paragraph 12).
- The RSE believes that the RAE system should be monitored to ensure that proper weight is given to both basic and strategic research, and welcomes the increasing emphasis on cross-research council programmes and the dual support system. (paragraph 16).
- While the Society welcomes the £4 million available to assist in recruitment of leading researchers, measures need to be taken to address the crucial issues of academic salaries and retention of the bulk of our talent and particularly how to deal with the problems that arise from the increase in the use of short term contracts. (paragraph 19).
- The recognition of the problem of immigration and work permit barriers to the recruitment and retention of overseas research workers and students is to be welcomed and a step towards improving UK competitiveness. (paragraph 21).
- Efforts to commercialise the research base need to continue and businesses, particularly the small and medium sized enterprises (SMEs), should be encouraged to use higher education institutions to greater effect. (paragraph 25).
- There is perhaps an insufficient recognition within the White Paper that in some regions the industrial base simply does not exist to exploit the scope for collaboration with academia. This means that benefits flowing to the local area are indirect and therefore limited. There is a need to establish more technical research and development facilities to support SME communities. (paragraph 28).
- It would have been helpful to have a wider "Knowledge Transfer" theme within the paper which could have impacted on all government departments, for example into the creative industries, which would be of interest to the Department of Culture, Media and Sport. More emphasis could also have been given to the need for government departments to have a responsibility for maintaining a science base appropriate to their particular science advice and policy needs. (paragraph 31).
- An educated and informed electorate will respond to science-based policy decisions within the national political arena provided that government and the industry concerned are prepared to adopt an "open information" approach. (paragraph 33).
- The receipt by the Medical Research Council (MRC) of £53 million for its role in the cross-council genomics collaboration comes at just the right time to give a significant boost to the large-scale population studies that are investigating the interaction between genetics and environment/lifestyle factors. (paragraph 36).

GENERAL

3. The White Paper and the Science Budget are very welcome and will help to strengthen the UK science base. The broad approach embodies a real recognition of the importance of science and technology to the UK in the 21st century and the detailed proposals seem well directed to achieving improvement in key areas such as research infrastructure, support for young researchers, developing the business/academic interface and giving weight in the Research Assessment Exercise (RAE) to business-related research and development.

4. The specific details of the Science and Innovation White Paper and the Science Budget are addressed below:

SCIENCE AND INNOVATION WHITE PAPER "EXCELLENCE AND OPPORTUNITY"

5. The RSE welcomes the strategic direction described in the White Paper and its emphasis on scientific excellence, the creation of the right climate for innovation and the importance of excellent curiosity-driven research. The Society also supports the emphasis on knowledge transfer, the need to restore public confidence in science and the drive to attracting science students by improving science teaching in schools. In many respects the thrust of the White Paper is fully consonant with the RSE's own mission, goals and objectives as set out in the Society's new corporate plan.

6. The emphasis on having to gain public support for science and technology is particularly relevant at the present time with both science and engineering coming under the spotlight, for example, BSE, mobile phones and Railtrack. The public must feel in the long term that they are getting a commensurate return to their quality of life for the tax revenue invested by government.

Chapter 1: A Science Policy for the 21st Century

Devolution

7. The drafting of the White Paper highlights the difficulty of taking account adequately in such a document of the post-devolution situation. It is sometimes unclear whether a particular proposal applies UK wide or only to England and, in some cases, Wales. This underlines the importance of the key areas of science policy a good and close working relationship between Ministers and officials at the UK level and in the devolved administration. It is not clear that mechanisms exist to ensure that this essential collaboration is facilitated and more action should be taken by government to allow this to happen, for example in sensitising research council's agendas to national and regional priorities.

8. At the UK level, the Scottish science, engineering and technology (SET) base should remain an integral part of the UK system of basic research. Its scale benefits Scotland and the other regions of the UK by stimulating international competitiveness, through the inherent flexibility of a large system to adapt to change whilst focusing major efforts in areas of current need and the capacity to attract and retain scientists of international calibre. It must also not be disadvantaged when it comes to competing for UK funds such as those identified in this White Paper.

Excellence in science

Better science in schools

9. The RSE shares the concern about the need for greater appeal of science and engineering in schools, raised in the White Paper, and about the pay and conditions of school teachers and school laboratories. This responsibility is devolved to the Scottish Executive in Scotland, and a recent review of teacher's conditions of service (the McCrone Report) has lead to major pay proposals, to be funded by the Scottish Executive, and this should help with the recruitment of science teachers in Scotland.

10. Scientists and engineers involved in areas such as biotechnology and IT are becoming the bed-rock of a growing Scottish and UK economy. There is, however, a fall-off in interest and attainment at upper primary and lower secondary school levels but the underlying reasons are open to debate. The remedy certainly depends on good and enthusiastic teaching of science in primary and secondary schools. Part of the problem arises from the need to improve science teaching in secondary schools (although there are some notable exceptions). This in turn is a situation which has arisen through science teaching in schools having, over a good many years, appeared as an unattractive job option compared with other openings for newly qualified graduates in science.

11. To address these concerns the RSE will be seeking, as an expansion of its well-established and popular Young People's Programme, to foster a Teaching Fellowship Scheme for mid-career school teachers to enhance their professional and personal development. The RSE will also be seeking to introduce prizes and competitions that will extend participation of schools, teachers and pupils.

World-class infrastructure

12. The £1 billion programme in partnership with the Wellcome Trust to renew the science infrastructure is of great importance. Researchers in Scotland will be waiting eagerly to see how the Scottish Higher Education Funding Council (SHEFC) will translate the Science Research Investment Fund into action in Scotland as a result of its review of research funding and policy.

13. The Society also welcomes the £150 million being made available by the Wellcome Trust for top-rated, but unfunded, Joint Infrastructure Fund (JIF) bids and the £75 million of Wellcome Trust funding for equipment and refurbishment for biomedical science, together with the £100 million being provided by the OST for modernisation of research council institutes and development of large national science facilities.

14. With regard to the review of the Council for the Central Laboratory of the Research Councils (CCLRC), the Society believes that there should be a national strategy for the development of national and international facilities to be hosted in the UK (and also, some strategic objectives for the hosting of international facilities elsewhere) and that the CCLRC could perform such a strategic role, provided that it was given proper authority and funding to do so, and provided that it was properly advised and informed about the national strategy.

Funding excellent research

15. The SET base must aspire to excellence by international standards. Liberalisation of global markets requires that successful business should internationally competitive. It is increasingly free to locate itself where circumstances are favourable. For knowledge-based industries, this means in locations where there is an excellent SET base and a technically highly skilled population, which itself is part of the output of the SET base. Excellence, recognised by peer review judged against international standards, is therefore a prerequisite of an effective SET base. While the White Paper notes that the UK is second to none when spending on public

science is viewed in terms of value for money, there are certainly no grounds for complacency given the concerns about the falling numbers of physics, chemistry, engineering and technology graduates.

16. The RSE believes that the RAE system should be monitored to ensure that proper weight is given to both basic and strategic research, and welcomes the increasing emphasis on cross-(research) council programmes and the dual support system.

Funding priorities

17. The Society welcomes the specific initiatives in nanotechnology, e-science and genomics.

Academic rewards

18. The RSE supports the additional monies being made available as basic support for post-graduate research students and the comments about young researchers and the need to improve opportunities for women.

19. The Society welcomes the fact that £4 million will be available on a UK-wide basis to a Government/Wolfson Foundation/Royal Society partnership to assist in retaining leading researchers within the UK and attracting outstanding world class researchers here. However, there is nothing within the White Paper to address the crucial issues of academic salaries and retention of the bulk of our talent and particularly how to deal with the problems that arise from the increase in the use of short term contracts. In addition, the need to consider how the UK will generate the sort of people who will play key roles in the future to exploit the knowledge-based economy has not been addressed. The universities and other providers of higher education have a crucial role to play in producing the graduates with the skills and entrepreneurial flair essential to the creation of wealth in the 21st century. In addition, the provision of incentives for people to take risks, (including direct grants, low interest loans, well-serviced locations for growing companies in attractive surroundings with strong supporting infrastructure), are also important.

20. For its part the RSE intends to expand its support of advanced research and postgraduate studies, especially to promote technology transfer leading the wealth creation, improvements in the quality of life, and other Foresight priorities.

Attracting scientists and engineering to the UK

21. The recognition of immigration and work permit barriers to the recruitment and retention of overseas research workers and students and the proposals to remove them, are to be welcomed as a step towards improving UK competitiveness. There is, however, much to be done on the ground by the Home Officer before the ambitions of the White Paper are realised.

22. To assist this process, the RSE is also seeking to enhance schemes for shorter or longer-term overseas exchanges of researchers between Scotland and selected overseas countries.

Opportunities for innovation

Foresight

23. The £15 million fund for ideas from Foresight 2000 is welcome, While Foresight is given prominence within the White Paper, it remains to be established how Foresight research priorities will be interpreted by government departments and research funders such as the research councils and higher education funding councils.

24. The RSE will continue to organise its series of Foresight seminars, bringing together key people from Scotland's business, public and academic sectors, as part of the Society's Foresight contribution. The Society will also seek to organise workshops to identify and support selective research areas of high potential in which it is important that Scotland has a strategic presence.

Universities in the knowledge-driven economy

25. The White Paper correctly notes that our scientists and technologists are of a high global standard. For industry to benefit however, their outputs must be both relevant and timely. Effective knowledge transfer is heavily dependent on both mechanisms and culture and, as has been stated many times, there is a significant challenge in commercialising the output of our universities. Efforts to commercialise the research base need to continue and businesses, particularly the small and medium sized enterprises (SMEs), should be encouraged to use the institutions to greater effect.

26. It should be recognised, however, that this will not always involve exploitation of the results of research within the UK, though clearly that is to be preferred. The reality is, however, that industry within Scotland, or the UK, is not always in a position to pick up a piece of research and run with it. Spin-outs may not be

practical in all cases, though again the spin-out route has many attractions. In some cases the international quality and complexity of the research in our institutions means that it can only be exploited by international companies. Collaborative research with such companies can bring real benefits to the institutions, and to Scotland and the UK, and improve our standing as a centre of excellence at an international level.

27. The RSE awards Enterprise Fellowships that equip post-doctoral researchers, or younger lecturers, with the hands-on business knowledge to enhance the commercialisation potential of their own research and to encourage the establishment of new start up companies based on Scottish and UK research achievements. In the past four years the 13 Fellows who have completed their Fellowships have formed, or been part of, eight successful spin-out companies. Because of this success, the Society will be seeking to increase the number and subject coverage of the Enterprise Fellowships in partnership with other bodies. The Society will also be running a series of Science Base Research and Commercialisation (SBRC) workshops, focusing on best-practice within the Scottish Science Base, with an emphasis on spin-outs, licensing, IPR processes, job creation, challenges in engaging the Scottish industrial base, incubators, the impact of the RAE, and the relevance of Foresight.

Stimulating demand from business

28. Over the last few years, considerable emphasis has been placed on encouraging commercialisation of research-generated ideas. However, one of the major weaknesses of the Scottish economy in this respect is the absence of locally-based businesses capable of developing such ideas. The model currently is very much one of higher education institutions (HEIs) "pushing" research findings out into the community rather than industry "pulling" such ideas and actively developing them. Scotland does not lack "institutional push"; it does, however, lack "industry pull". Of the top 10 publicly-quoted companies in Scotland, five are either banks or utilities and as a country, we have too few major directly research-dependent industries. There is, therefore, perhaps an insufficient recognition within the White Paper that in some regions the industrial base simply does not exist to exploit the scope for collaboration with academia. In some cases world class researchers cannot find any local businesses to work with and need to collaborate with industry outside their region or indeed outside the UK. This means that benefits flowing to the local area are indirect and therefore limited.

29. It is not easy to see how this can be addressed beyond encouraging such local collaboration as can take place, promoting academic spin-outs and attracting appropriate inward investment. A key objective must be to increase the number of companies performing effective R&D in these regions. This will be a long-term goal and, therefore, while efforts to attract inward investment should continue, these should be matched with a comparable development of Scotland's indigenous industry. It has to be recognised that building an R&D culture and capability is both risky and expensive for smaller companies and is, therefore, unlikely to happen without significant public investment.

30. There is a need to establish more technical research and development facilities to support SME communities and, in terms of vocational skill development, the strong interfaces being developed between HE and FE and articulation with HND qualifications is an excellent model in Scotland. The RSE will also be seeking to create an Industry Fellowships Scheme to bolster the links between industry and the science base in Scotland. These Fellowships will be awarded to industrial applicants to carry out relevant research programmes in partnership with a Scottish university or research institution.

Strategies for government departments

31. Innovation is about more than science of technology transfer. It would have been helpful to have a wider "Knowledge Transfer" theme within the paper which could have impacted on all government departments, for example into the creative industries, which would be of interest to the Department of Culture, Media and Sport. More emphasise could also have been given to the need for government departments to have a responsibility for maintaining a science base appropriate to their particular science advice and policy needs, and in providing proper overheads in research grants and contracts.

Intellectual property: changing the rules

32. The interest by government in the issues of intellectual property (IP) management is welcome, as is the £10 million gap-bridging fund for commercialisation of IP in public sector research establishments (PSREs). The issue is already on the agenda of Universities UK and the Association for University Research and Industry Links (AURIL) where tensions are recognised between disclosure, publication and protection as well as issues of employment conditions, rights of individuals, and the expectation that institutions will exploit their assets.

Confident consumers

33. There is a risk that anti-science attitudes will limit the range of options available for the commercial exploitation of opportunities in some science-based areas. An educated and informed electorate will respond to science-based policy decisions within the national political arena provide that the Government and the industry concerned are prepared to adopt an "open information" approach. In Britain the Freedom of Information Bill should address this issue in part. Public caution is understandable and desirable but present attitudes to scientific advances and their commercial exploitation are rarely based on rational appraisal and often exhibit a failure in popular understanding of risk.

34. There are various techniques for engaging the informed general public in debates about the future of science and technology, and in Scotland the Consultative Steering Group for the Scottish Parliament has recommended that such techniques should be pursued in order to widen the base of participation in political decisions. This degree of openness to more imaginative approaches should be welcomed and encouraged. Events involving senior school pupils building on the concept of consensus conferencing, by organisations such as the British Association and the Royal Society of Edinburgh, represent useful initiatives at developing public awareness of science issues. The RSE is also seeking to engage the interest of the public and the media in news-driven public debates, in a range of piloted formats, exploring multifaceted arguments from experts (Fellows and non-Fellows) on matters of topical interests and current affairs.

SCIENCE BUDGET 2001–02 TO 2003–04

Main Changes for the years 2001–02 to 2003–04

35. Although the funding might appear generous, the multiple funding streams now accessed by universities risk making this system less effective than it could, and should, be. In addition, the scale of funding of the "Cambridge MIT Institute" of £65 million is larger than the total public funding into either university or science enterprise challenges. The objective "to collate and disseminate information on best practice and emerging knowledge from CMI to all universities and the business world" is also very hierarchical and unidirectional. It would have been useful if some funds could go to helping recipients absorb and implement this best practice.

Allocations to funded bodies

36. The receipt by the Medical Research Council (MRC) of £53 million for its role in the cross-council genomics collaboration is very encouraging. The funding comes at just the right time to give a significant boost to the large-scale population studies that are investigating the interaction between genetics and environment/lifestyle factors. This will be of particular significance in Scotland where we have considerable existing strength (MRC Human Genetics Unit, Edinburgh; strong human genetics departments in universities, Scottish Cancer Genetics Consortium, and excellent linked data registries). The RSE also supports the identification of mental health alongside cancer and heart disease as an area to be boosted by the MRC. These three areas remain the stated priorities of the Scottish Executive Department of Health and the NHS in Scotland.

ADDITIONAL INFORMATION

37. Within the White Paper, the term "science" appears to be used as an umbrella term for science, engineering and technology (SET). The Society believes that this is unhelpful. The three are inextricably linked, and not using the term SET frequently leads to the exclusion of the necessarily broader thinking which encompasses all three from the discussion. Science, engineering and technology are all important within the educational context and support for the engineering disciplines, in particular, is important if knowledge transfer into technology is to remain healthy.

38. In responding to this inquiry the RSE would like to draw attention to the following Royal Society of Edinburgh responses which are of relevance to this subject: The Scientific Advisory System (June 1998); Devolution and Science (April 1999); Science and Society (June 1999); Government's Expenditure on Research and Development: Forward Look 1999 (December 1999); Are We Realising Our Potential (June 2000); Science Strategy for Scotland (July 2000) and the Royal Society of Edinburgh Corporate Plan 2001–06. Copies of the above publications are available from the Research Officer, Dr Marc Rands (email: mrands@rse.org.uk).

29 January 2001

Supplementary memorandum submitted by the Chemical Industries Association

We have chosen to submit comments based on the following broad themes which the consultation paper encompasses:

1. Science and Innovation White Paper, *Excellence and Opportunity*, July 2000.
2. Science Budget 2001–2 to 2003–4.

Our comments are set out below.

EXECUTIVE SUMMARY

CIA applauds the Science and Innovation White Paper and Science Budget for the period 2001–2 to 2003–4 since they send a very clear signal that the Government recognises and appreciates the key role of science and engineering in the UK.

If the plans and expenditure proposals contained within these documents are carried out as outlines, then the science base in the UK should be strengthened enormously, reversing the decline over the past decade.

CIA believes that special emphasis still needs to be placed by Government on science teaching, especially in primary schools; the issue of student quality, quantity and debt management; HEFCE's Research Assessment Exercise; innovation and marketing; Intellectual Property Rights and the public acceptance of science–areas which are all vital in supporting and promoting science in society in this country.

Science education must begin at primary school level in order that sciences role in, and importance to, society is firmly embedded in the minds of children at an early age.

The lack of suitably qualified primary school science teachers, poor school facilities and the curtailment of the teaching of science in schools due to the impinging effects of Health and Safety legislation, present real barriers to exciting the interest of children in the study of science, especially chemistry.

Student quality, quantity, and the increasing financial burden on students are important issues for the Government to tackle in order to ensure that the chemicals industry has a steady stream of high quality science and engineering graduates.

The Research Assessment Exercise (RAE) needs to be radically altered to reward academe for their strengths in teaching, research and/or technology transfer.

Greater emphasis urgently needs to be placed on business-driven innovation so that inventions developed in the UK are fully exploited by industry in this country.

The Government's desire to transfer ownership if IPR, generated as a result of publicly funded research, to academe needs to be properly evaluated, especially if industry is involved. We believe that industry should have the right to all IPR which arises as a result of any collaborative venture with academe. Industry should be the preferred entity for marketing the innovation, and generating wealth as a result of any new knowledge.

The Government and industry must work together on improving the public's acceptance of science.

The Government and industry must continue to fund curiosity-driven research, and not focus solely on application driven research.

The Government must recognise that there is a significant and existing science and technology base which is strategically important to the UK and underpins some of the current "sexy" areas such as nanotechnology.

The vast number of Government funded innovation support schemes should be reduced to a select few. This will be of tremendous assistance to both industry and academe in reducing the time and money spent in their search for grants.

The Government should not overlook the importance of the chemical sector to the UK economy since it often develops and supplies the basic raw materials, some of which are extremely innovative and complex, for use by other "high-technology" industries such as pharmaceuticals and telecommunications.

1. SCIENCE AND INNOVATION WHITE PAPER, EXCELLENCE AND OPPORTUNITY, JULY 2000

CIA applauds the Science and Innovation White Paper, published in July 2000, since it represents a clear demonstration of the Government's commitment to science and innovation in the United Kingdom.

The White Paper provides a clear synopsis of Government's strategies for:

— promoting scientific excellence through an investment of £1 billion (£775 million from Government and £250 million from the Wellcome Trust) in the Science Research Infrastructure Fund, an additional allocation of £250 million in key research areas: genomics, e-science and basic technology, an increase in basic support for postgraduate students to £9,000 per annum, and by allowing overseas students to obtain a work permit with relative ease so that they may remain in the UK and contribute to its science base;

- increasing the profile of science and technology in schools by running a "science year" in 2001–02, and by creating a "science ambassadors" programme whereby former science students encourage the up-take of science and technology in their old schools;
- supporting innovation by creating a Higher Education Innovation Fund (incorporating the Higher Education Reach Out to Business and the Community Fund) worth £140 million, doubling of Faraday Partnerships from four to eight, allocating £15 million to a new Foresight Fund to exploit ideas from the Foresight programme, recognising the role and importance of intellectual property in facilitating innovation, and improving industry-academe collaborations by providing £50 million per annum to the Regional Innovation Fund, and support for 20 business fellows;
- recognising the importance of a public dialogue on the role and importance of science in society, especially the need for improving consumer confidence in science. The proposal to develop stronger guidelines for use of scientific advice by Government, and a code of practice for Government scientific advisors is to be welcomed.

Although the Government's White Paper is thorough and wide-ranging, it is not revolutionary. It does, however, represent a positive step change for the United Kingdom by providing a firm foundation for investment in, and exploitation of, science in this country.

CIA believes that special emphasis still needs to be placed on science teaching, especially in primary schools; the issue of student quality, quantity and debt management; HEFCE's Research Assessment Exercise; innovation and marketing; Intellectual Property Rights and the public acceptance of science—areas which are all vital in supporting and promoting science in society in this country.

Our specific comments on each of these topics are briefly outlined below:

Science teaching in primary schools

The lack of suitably qualified primary school science teachers, as exemplified by the Council for Science and Technology's project on science teachers undertaken last year, poor school facilities, and the curtailment of the teaching of practical science in schools due to the impinging effects of Health and Safety legislation, are of worry to CIA. They present real barriers to exciting the interest of children in the study of science, chemistry in particular, at primary school level.

We feel that it is vital to teach, and to extol, natural sciences at this level in order to ensure that science's role in, and importance to, society is firmly embedded in the minds of children at an early age.

Scientifically qualified and confident primary school teachers play an instrumental role in this regard, and greater effort needs to be placed by the Government on the recruitment, retention and motivation of individuals who wish to pursue a career in teaching science in primary schools.

The poor state of science facilities and equipment in schools can also curtail the undertaking of scientific experiments at primary [and secondary] school level. This problem is further compounded by excessive application of Health and Safety legislation which can act as a deterrent to schools.

It is worth stressing that science is an intensely practial subject, and it is this aspect which is immensely appealing to young people. The lack of proper school facilities and science equipment must be reversed if we are to encourage school children's interest in science.

The Government's desire to increase the profile of science and technology in schools by running a "science year" in 2001–02 is most welcome. However, we feel that a long-term national strategy needs to be formulated in this regard. The principal aim of which will be to develop an effective synergy between the wide number of organisations in the UK that are actively involved in promoting science to young children.

Students—quality, quantity and debt management

We feel that the student quality and quantity, together with the increasing amounts of financial burden which they now face, needs to be urgently reviewed and resolved by Government.

Many CIA member companies increasingly report variable standards of student quality depending on the Higher Education Institution they attend. This is especially the case in natural sciences and engineering graduates in their level of scientific knowledge, practical ability and interpersonal skills. We believe that the decline in student quality over the last decade may be attributable to poor standards in teaching and training at some universities, and also within schools.

Secondly, CIA is worried by the general decrease in student numbers undertaking natural sciences and engineering, due to the perceived lack of reward and future/long-term career prospects. Training in subjects such as business administration, economics, information technology, or law is deemed to offer a much better long-term career with enhanced employability prospects compared to a career in the sciences.

Thirdly, student debt, accumulated during undergraduate years at university, now plays an important role in preventing some students from undertaking a PhD programme (especially in chemical engineering) or even completing their undergraduate course. A large proportion of undergraduate students are more concerned about clearing their student loans rather than pursuing a further qualification which will burden them with even more debts.

Whilst we welcome the Government's proposal to increase the basic support for post-graduate research students to £9,000 per annum by 2003–2004, we would like to see some more detail as to how this increase will affect industry and the students it sponsors as businesses do not have a bottomless pit of money.

Overall, the future success of the chemicals industry—a knowledge-driven and knowledge-intensive sector—depends upon a steady stream of high quality science and engineering graduates from universities. We hope that the Government will urgently address the sad demise of student quality, quantity, and increasing levels of debts in the UK.

HEFCE's Research Assessment Exercise

CIA believes that HEFCE's Research Assessment Exercise (RAE) should be radically altered to reward academe for their strengths in teaching, research and/or technology transfer. The RAE should not judge Higher Education Institutions primarily on research outputs such as publication rate since this represents just one of a range of assessment measures/metrics.

Instead a formal bidding system and the use of a strategic plan should form the basis of any RAE since the bidding system and the use of plans would allow an institution to describe its focus and future plans clearly (either in teaching/training, research and/or technology transfer) together with a critical assessment of its strengths and weaknesses.

The RAE should also reward true interdisciplinarity, and not just single subject research collaborations.

Although HEFCE has undertaken a fundamental review of the RAE post 2001, we feel that it has not substantially altered the status quo. In fact, the RAE needs to reflect and act on our views which are also supported by other eminent bodies like the CBI. This would ensure that the UK retains a high quality and strategically focused science base which continues to be attractive to industry, especially the chemicals sector. A copy of CIA's submission to the HEFCE on their consultation on the RAE post 2001 is attached for information.

Innovation and Marketing

The Science White Paper recognises the importance of innovation to the knowledge-driven UK economy. However, CIA strongly feels that it uses the term innovation very loosely, both to mean "creativity" and its more correct definition of "bringing technology to the market place".

Innovation is driven by three facets, namely, ideas, technology and business. As a nation, we are extremely creative, especially in the generation of ideas and technology–a glowing tribute of our strong and dynamic science base which we hope will always be maintained and strengthened.

We believe that our culture is very much technology push rather than market pull, and greater emphasis urgently needs to be placed on business-driven innovation, in particular, the integration of marketing strategies with research and development activities, as observed in countries such as Japan and the United States of America.

We are therefore disappointed to learn that the White Paper fails to make any direct mention of the marketing of innovation although it does mention markets and their creation in the context of innovation.

CIA believes that a real culture change is required in the UK if it is to capitalise on its innovative prowess. This in turn will help to prevent British inventions from being exploited overseas, thereby negating wealth creation here. One possible solution to initiate the culture change is to develop a new breed of scientist and engineer who not only understands technology but also marketing.

The Research Councils should also place more resources into understanding the cultural issues of technology push *vs* market pull. We believe that a series of recommendations need to be developed on how the UK can change its culture, and how we influence Government, society and the captains of industry, to make the change happen.

We also feel that one of the "innovation gaps" lies in the demonstration of research ideas through to pilot industrial scale. Some years ago, the DTI phased out the funding of demonstration projects, and we would now like these to be re-evaluated since they proved immensely useful in promoting developmental activities in the UK. Any supportive Government measures on this account will be most welcomed by CIA.

On another important note, the White Paper tends to focus a great deal on knowledge intensive/high technology sectors such as pharmaceuticals, telecommunications, information technology. This is at the expense of more "traditional" knowledge-based industries such as chemicals. We strongly feel that the Government should not ignore the role and importance of the chemical sector, which is research-intensive, innovative and often develops complex materials for use by the so-called "high-technology" industries.

Intellectual Property Rights

Intellectual Property Rights (IPR) will increasingly play a distinctive and pivotal role in the knowledge-driven economy which will underpin innovation, and drive enterprise in the United Kingdom.

Whilst CIA supports the Government's belief that effective IPR management should be a fundamental goal of universities and research bodies in the public sector, we feel that the impact, transfer and ownership of IPR generated as a result of government funded research to academe needs to be properly evaluated. This is especially the case if industry is involved in the project in order to avoid potential industry-academe conflicts. This development will hinder Government's desire to foster close and mutually beneficial industry-academe partnerships.

The Government's proposal on IPR ownership is probably based on the positive impact in America on technology transfer from academe to industry due to the 1980 US Bayh-Dole Act. Many industrial organisations, who wish to collaborate with US universities, find IPR a principal issue of contention in facilitating their relationship. The prime reason for this is that US institutions wish to retain and control intellectual capital. In contrast, UK universities are much more easier to collaborate with, and negotiate on, IPR. We want this status quo to continue.

We believe that industry should have the right to all IPR generated as a result of any collaborative venture with academe, and certainly if the research work has been supported by industry and Government. Industry should be the preferred entity for marketing the innovation, and generating wealth as a result of any new knowledge.

On another IPR issue, we hope that Government will support initiatives such as the European Commission's proposal for a regulation on the Community Patent. This regulation, if enacted, will foster innovation in Europe. Both industry and academe will benefit from a substantial reduction in prosecution, translation and maintenance costs associated with generating IPR which are currently very high. We feel that a strong but cost effective IPR regime is certainly warranted within Europe.

Finally, the recently announced "Intellectual Property Portal" is to be welcomed. We feel that the portal has the potential to be a powerful knowledge bank of, and tool for accessing, information on IPR for both users and creators provided that it is properly managed and developed by Government.

Overall, IPR is an important strategic tool for the chemical industry. It can be described as a new currency since it is a tradeable commodity. The chemical sector's competitiveness and survivability depends upon it for its future success.

Public acceptance of science

There has been a gradual but worrying erosion of confidence and trust in science, including its regulation, due to high profile issues such as BSE. CIA believes that improving public acceptance and confidence in science, and its industrial exploitation, is vital to progress and innovation in this country. A key to this is trust in, and impartiality of, scientific advice supported by an open assessment of the risks associated with science through a transparent and effective system of regulation by Government that does not stifle innovation.

The Science and Innovation White Paper acknowledges the need to for greater openness and transparency within Government, especially in its use of scientific advice in policy making. We welcome this development, including the revised version of the 1997 guidelines on "The Use of Scientific Advice in Policy Making" by the Government Chief Scientific Advisor.

The public understanding of science, including risks and benefits associated with it, also needs to be improved greatly. Science-based industries, such as the chemical sector, also have an important role to play in helping to improve the image of science. For example, the chemical industry has embarked on a number of voluntary initiatives such as Responsible Care and Confidence in Chemicals which aim to reduce risks and environmental impact of the use of chemicals.

CIA is now increasing its support for the teaching of science in primary schools, in order to give children a feel for the excitement of science while they are still able to express wonderment and curiosity.

A robust education system, supported by trained teachers at primary and secondary school level who teach science in a positive, enjoyable and open and pragmatic manner, is vital if Government is to make any impact on this issue. Our comments to you in your consultation on the impact of the 1993 White Paper, "Realising Our Potential", deals in greater detail on the campaign to spread understanding amongst school children and the public.

Finally, we hope the Government will see industry as worthy partners in this endeavour.

2. SCIENCE BUDGET 2001–02 TO 2003–04

CIA welcomes the allocation of the science budget for the period 2001–02 to 2003–04 as a result of the 2000 Spending Review. This has resulted in a positive financial outcome for the science and engineering base in the United Kingdom.

Although the science budget follows the proposals outlined in the Science and Innovation White Paper quite closely, we would like to make the following additional comments.

— The Government must continue to fund curiosity-driven research, and not focus mainly on applied research. It is vital to recognise that there is a significant and existing science and technology base which is strategically important to the UK and underpins some of the current "sexy" areas such as green technology.

— Chemistry is one such underpinning science and it does, and will continue to, play a significant role in technology areas such as biotechnology, functional materials for the electronics industry and nanotechnology (including catalysis).

— The Government must be careful about funding "buzz-words" of the moment, only to drop them after two to three years if the science and technology does not mature as fast as they would like. However, CIA does recognise that continual investment is required in areas that are regarded as strategically important to the UK but the emphasis must be on core science and technology areas not specific projects.

— There are far too many initiatives and sources of grants which currently exist for funding science and technology projects. Although the Higher Education Innovation Fund incorporates the Higher Education Reach Out to Business and the Community Fund, the Science and Innovation White Paper does nothing to reduce the numerous different funding schemes.

We believe the Government should rationalise the total number of funding streams by combining or terminating some of them but without reducing the overall funding levels. This will be of tremendous benefit and value to both industry and academe in reducing the time and money spent in their search for grants.

Closing Remarks

The 2000 Science and Innovation White Paper and Science Budget for the period 2001–02 to 2003–04 represent important milestones in sending a very clear signal that the Government recognises, appreciates and supports the key role of science and engineering in the UK.

If the plans and expenditure proposals contained within these documents are carried out as outlined, then the science base in the UK should be strengthened enormously reversing the decline over the past decade. CIA now eagerly awaits to see how the Government will translate their proposals into effective implementation plans.

We hope that we have identified some of the issues which the consultation needs to take into consideration and address. Through its Science, Education and Technology Committee (SETCOM) the CIA and its member companies welcomes this opportunity to work closely with the House of Commons Science and Technology Committee so that the SET base in the United Kingdom can be strengthened, for the benefit of Government, industry and academe.

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